Timber Yield and Financial Return Performance of the 1974 Forestry Incentives Program

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Abstract

Analysis of the timber production performance of the 1974 Forestry Incentives Program (FIP) showed that the average "real" rate of return on timber-associated inputs and outputs of the 1974 investments was 10-1/4% on the direct treatment costs. Seventy-five percent of the cases earn a 6-3/8% return. The first rotation yield increase is estimated at 1.04 billion cubic feet, mostly softwoods, occurring within 50 years of the initial treatment. The program overall had high average returns, but some major segments had low returns. Five recommendations, aimed at eliminating low return segments by developing silvicultural guidelines for the screening of cases, development of maximum cost standards, and insuring the follow-up treatments are taken, are proposed.

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Introduction

The enabling legislation for the Forestry Incentives Program (FIP), P.L. 93-86, authorizes the Secretary of Agriculture to share the cost of forestry practices with nonindustrial, private forest landowners. The legislative history (Sikes 1973) and the wording of the act (U.S. Congress 1973) list several resource management goals, but increased timber production appears as the primary goal. Similarly, the President's (1973) directive upon signing the bill into law called for development of a cost-effective timber production program.

Early administrative decisions concerning FIP addressed other program goals such as soil conservation and enhancement of recreation opportunities and wildlife habitat. Increased timber production, however, predominated as the major program goal. (USDA Secr. Agric. 1973, USDA-FS 1947a, USDA-ASCS 1974, Mills et al. 1974).

The enabling legislation restricted participation to owners of less than 500 acres of forestland unless a special waiver is approved by the Secretary. The federal cost-share rate could vary from 50% to 75% of the direct practice cost. In 1974, Secretary of Agriculture administrative regulations further restricted participation to tracts with a production potential of more than 50 cubic feet of timber per acre per year. In tree planting practices, owners were not eligible for cost-sharing assistance if they had commercially harvested timber in the previous 5 years on the tract to be cost-shared. Other major changes in program regulations have been instituted since 1974.

The program is jointly administered by three cooperating agencies. The USDA Forest Service (FS) provides technical input such as forestry practice specifications and recommendations for funding apportionment procedures. The USDA Agricultural Stabilization and Conservation Service (ASCS) has the major program administration responsibilities of owner eligibility, waiver applications, and cost-share payments to participants. State forestry agencies and private forestry consultants provide on-site technical assistance to eligible landowners. State forestry personnel also check the installed practice before payment is issued to be sure it complies with practice guidelines.

Study Justification

The law required periodic reports to Congress on FIP performance. An interagency Program Development Committee, established in USDA in 1974, also requested a rigorous evaluation of the performance of FIP. Performance evaluations and cost-effectiveness were central issues. There is also a standing USDA policy which requires an early performance evaluation of new programs (USDA Secr. Agric. 1972).

The FIP evaluation plan, prepared in response to the Program Development Committee's request, outlined a three stage evaluation of the 1974 program performance (USDA-FS 1974b). The first stage described the program composition and rated performance by a number of cost-effectiveness indicators. The results of the first stage evaluation of 1974 performance indicated that program performance was generally favorable with respect to cost effective timber production but improvement was possible (Mills 1976, Mills and Cain 1976). The second stage evaluation, reported in this paper, estimates the potential financial return and timber yield increase from FIP investments. The future third-stage evaluation is designed to evaluate the treatment follow-up and retention of the FIP investment cases.

Study Objectives

Two objectives were sought in this study:

primary objective: estimate the timber yield increase likely from the FIP assistance cases administered in 1974 and estimate the financial return associated with that timber yield increase, and

secondary objective: determine the performance of major segments of the 1974 program with respect to timber output in order to develop recommendations on how future program performance might be improved.

Both objectives concentrate on only the timber aspect of FIP performance on the investments actually installed in 1974. The analysis questions whether the timber yield and value increase likely to result from the FIP treatment can justify the increase in management cost. A marginal analysis format is used which implicitly assumes that the land would be growing trees, with or without the FIP practice.

The 1974 Evaluation Year

FIP assists from 1974 were analyzed in this study. Questions have been raised about how well the first year represents the program. Program delivery started late the first year due to a Presidential appropriation recision request which Congress subsequently overrode. Also, it took time before smooth operating procedures were developed to deliver the program through a delivery system including ASCS, the Forest Service, and State forestry agencies. The initial concern was development of an operational program while the question of program composition was secondary.

The 1974 cases on the other hand, were prescribed and checked by professional foresters in the State forestry agencies. These same foresters had delivered forestry assistance under the Agricultural Conservation Program (ACP) and the Cooperative Forest Management (CFM) Program for years.

In 1974, there was also a backlog of high potential cases and very receptive landowners in some states which may not be common in later program years. The President issued appropriation recision requests again in 1975 and 1976. It might be difficult to select a "typical" year for evaluation, but this earliest possible evaluation will provide program guidance.

In spite of these pros and cons about selection of 1974 as a sample year, there is ample evidence that program guidelines have been progressively focused to enhance timber production performance. For example, most states have set increasingly higher tract size minimums than the nationwide guideline for a 10-acre tract size minimum (USDA-ASCS 1977b). Average tract sizes have risen significantly since 1974, almost doubling for both reforestation and timber stand improvement practices (table 1).

High cost practices have drawn increasing attention since 1974. No formal guidelines have been established at the national level, however, except for the minor component of fencing. Average direct costs (federal plus private share) have risen 27% on site preparation and planting (FP-1). This cost increase on planting is slightly more than the 21% increase in the All Commodity Wholesale Price Index (WPI) over the same period. This is consistent with the findings of Moak et al. (1977) that silvicultural treatment costs in the South, between 1967 and 1976, rose faster than the All Commodity WPI. The average direct cost of timber stand improvements (FP-2) has not risen at all between 1974 and 1977.

The 5-year period harvest rule was removed in 1978. This will probably lead to earlier and less costly site preparation than under the earlier regulations. The State service forester can now specify the federal cost-share rate on a case-by-case basis as long as the cost does not exceed the State maximum and the cost-share percentage is not less than 50%. This too should lead to lower average costs since the State level cost-share maximums were used on almost all cases before. These program changes should be kept in mind when interpreting study results.

Study Procedures

The complete population listing of assistance cases administered in 1974 was stratified into 77 separate sample "cells" and sample cases were randomly drawn from each cell. Investments were analyzed within a marginal analysis format which compared the probable costs and returns without the FIP investment with those likely once the FIP investment was installed. Several types of data were required in the marginal analysis approach, including ground measurements on pre- and post-treatment stand conditions, treatment costs, stumpage prices, management regimes, and yield estimates. These inputs were estimated as closely as possible for case-specific conditions. Then the financial return to timber production and timber yield increase was estimated for each sample case. Sample case results were expanded to total population estimates and aggregate program results were compiled. High and low performance

Table 1. Average direct treatment cost and average tract size in FIP from 1974 to 1977, by practice

Program year	Average direct cost[1]		Average tract size	
	Reforestation[2]	Timber stand improvement[3]	Reforestation	Timber stand improvement
	(dollars/acre)		*(acres)*	
1974	52	29	15.3	17.9
1975-76[4]	68	25	18.6	32.7
1977	66	29	29.1	31.7

Source: USDA-ASCS report EL-11-R which includes all cases completed and paid during the specific period. Wash. D.C.

[1] *Included the federal and private cost-shares*

[2] *Practice FP-1.*

[3] *Practice FP-2.*

[4] *Includes the short 1975 year when funds were received late, the full FY 1976, and the transition quarter when the FY was changed from July to October.*

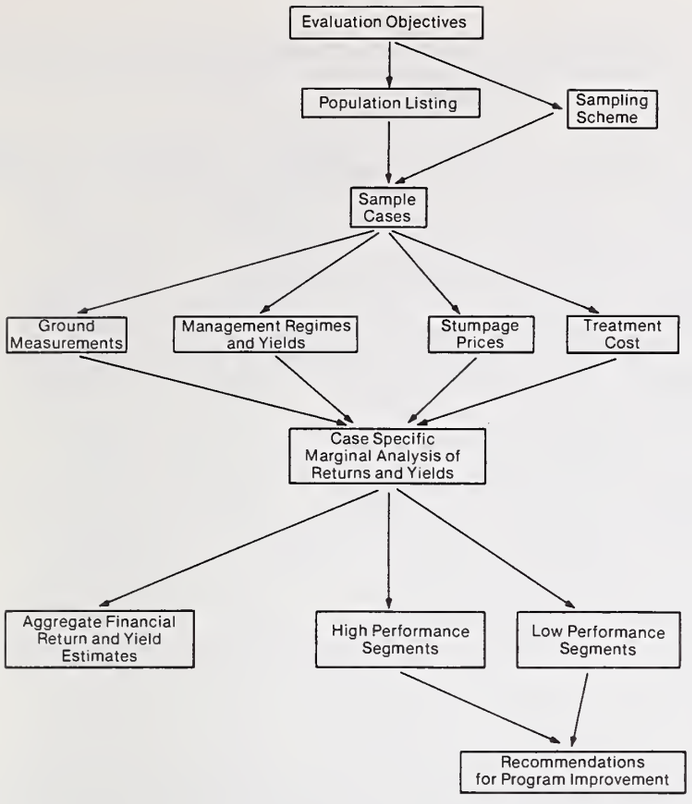

Figure 1.—Schematic representation of major study sections.

segments were then identified which led to recommendations for improved performance. Figure 1 presents a schematic representation of these steps and shows the order in which procedures and results will be described in detail.

Sampling Scheme

A complete population listing of the 15,849 FIP cost-share assists administered in 1974 was developed for the first-stage FIP evaluation. Information on tract size, percentage cost-share rate, and federal cost-share expenditures was available for each case. Site class, pre- and post-treatment forest type, broad practice class, and state identifications were also available. Miscellaneous practices such as fire roads and fencing — some of which can no longer be cost-shared with FIP funds — were excluded from the population list because of their unique evaluation problems. The excluded miscellaneous practices accounted for only 1.5% of the federal cost-share expenditures in 1974 and have had a similarly small role in subsequent program years.

Based on the two evaluation objectives, the population list was stratified by broad practice and forest type groupings. The population was further stratified by state because of the important role that State forestry agencies have in the technical direction of the program.

Separate sample cells were identified if cases within that cell totalled more than 1,500 acres. States were separated for individual sampling if more than 1.5% of the 1974 treated acreage was within the state and if more than 75% of the treated acres occurred in one of the broad practice-forest type strata. If a state was not separately identified or if one of the broad practice-forest type strata was small in an identified state, the cases were placed in an "Other North," "Other South," and "Rocky Mountain" or "Pacific Coast" strata. Practices that were not individually identified in any of the major broad practice-forest type strata were placed in an "Eastern Residual" or "Rocky Mountain Residual" cell for sampling purposes.

This stratification approach identified 77 separate sampling cells, with 38 in the South, 33 in the North, 4 in the West, and 2 residual cells. Thirteen separate practice-forest type strata were employed and 20 states were individually recognized for sampling purposes (table 2). Population cases were then separated into nine subcell stratifications by three federal cost-per-acre classes and three site classes.

With no prior information on the variance of financial return and increased yield within sample cells, sample size was a function of intuition and time and cost constraints. Twenty sample cases were drawn from each sample cell with a minimum sampling intensity of 3% and a maximum sampling intensity of 50%. Samples were proportionally allocated among the nine subcell strata and systematically drawn after a random start.

A total of 1,439 sample cases were drawn under this approach in the East and 90 were drawn in the West. In July 1975, a few sample cases still identified as only "substantially completed" were replaced by "completed" cases drawn in the same manner as the original samples. Later, 96 cases were discarded due to incomplete or widely conflicting ground measurements.

This left a final sample of 1,354 cases in the East and 79 in the West. The resulting sampling intensity was 10% in the South, 9% in the North, and 16% in the West. The sampling intensity generally ranged between 6% and 18% for the states that were individually sampled.

All study results are in the form of population estimates. Sample results were expanded to population estimates by the following factor:

$$\text{expansion factor} = \frac{\text{no. population cases in sample cell}}{\text{no. sample cases in sample cell}}$$

This same expansion factor was applied to a sample case regardless of any post-stratification of the sample. All estimates of population means, such as average internal rate of return, were calculated as weighted averages where the tract size as well as the expansion factor were used as weights.

Table 2. Sampling cell, sample size, population size, and sampling

Species group and practice	State						
	Missouri	Alabama	Arkansas	Florida	Georgia	Louisiana	Mississippi
Southern pine, plant bare land	—	*(1)* 17 186	*(2)* 18 75	*(3)* 20 110	*(4)* 19 89	*(5)* 15 166	*(6)* 24 293
Southern pine, site preparation and planting	—	*(11)* 23 481	*(12)* 21 77	*(13)* 20 197	*(14)* 22 652	*(15)* 25 122	*(16)* 17 415
Southern pine and oak-pine, precommercial thin, and release	*(22)* 13 71	—	*(23)* 15 153	—	*(24)* 10 36	*(25)* 19 70	*(26)* 14 62
Southern pine, and oak-pine, cull tree removal	*(30)* 10 35	—	*(31)* 8 56	—	*(32)* 16 29	*(33)* 10 26	—
Northern pine, site preparation and planting	—	—	—	—	—	—	—
Eastern residual	—	—	—	—	—	—	—
Total[2]	[3]87 507	44 714	64 449	42 327	67 822	69 413	58 888
Percent sampled	17.16	6.16	14.25	12.84	8.15	16.71	6.53

Species group and practice	State				
	Michigan	Minnesota and Wisconsin	Vermont	Maine	New Hampshire
Northern pine, and spruce-fir, plant bare land	*(39)* 25 388	*(40)* 25 810	—	*(41)* 19 255	—
Northern pine, and spruce-fir, site preparation and planting	*(43)* 12 137	*(44)* 16 225	—	—	—
Northern pine, and spruce-fir, precommercial thin, and release	—	—	—	*(46)* 20 191	*(47)* 25 250
Northern pine, and spruce-fir, prune	*(48)* 19 108	*(49)* 20 59	—	—	—
Oak-hickory, precommercial thin, and release	—	—	—	—	—
Oak-hickory, cull tree removal	—	—	—	—	—
Maple-beech-birch, precommercial thin, and release	*(55)* 21 191	—	*(56)* 23 109	*(57)* 16 59	*(58)* 17 106
Maple-beech-birch, cull tree removal	*(61)* 15 88	—	—	—	—
Total	99 1025	68 1296	29 180	63 601	46 439
Percent sampled	9.66	5.25	16.11	10.48	10.48

percentages[1] by geographic region, species, and practice group.

State								
North Carolina	Oklahoma	South Carolina	Texas	Virginia	Other South	Eastern residual	Total[4]	Percent sampled
(7) 14 139	—	(8) 16 80	(9) 23 154	(10) 13 116	(35) 20 60	—	199 1468	13.56
(17) 39 1114	(18) 19 34	(19) 24 229	(20) 18 167	(21) 27 498	(36) 19 191	—	274 4177	6.56
—	(27) 17 51	—	(28) 19 51	(29) 17 56	(37) 17 233	—	141 783	18.01
—	—	—	—	—	(38) 8 84	—	52 230	22.61
(34) 21 191	—	—	—	—	—	—	—	—
—	—	—	—	—	—	(71) 29 949 (72) 5 235	—	2.87
83 1605	39 96	41 336	60 389	57 683	64 568	34 1184	[5]666 6658	10.00
5.17	40.63	12.20	15.42	8.35	—	2.87	10.00	

State						
New York	Pennsylvania	Indiana	Missouri	Other North	Total	Percent sampled
—	(42) 21 210	—	—	(63) 27 679	117 2342	5.00
—	(45) 14 195	—	—	(64) 13 468	76 1216	6.25
—	—	—	—	(65) 30 389	75 830	9.04
—	—	—	—	(66) 21 191	60 358	16.76
—	(50) 9 95	(51) 19 58	(52) 26 109	(67) 18 596	72 858	8.39
—	—	(53) 19 80	(54) 26 116	(68) 28 391	73 587	12.44
(59) 20 340	(60) 25 90	—	—	(69) 15 171	137 1066	12.85
(62) 20 86	—	—	—	(70) 9 65	44 239	18.41
47 573	80 775	44 225	87 507	161 2950	654 7496	8.72
8.20	10.32	19.56	17.16	—	8.72	—

Table 2. Continued

Species group and practice	Region: Pacific coast	Region: Rocky mountains	Region: Total	Percent sampled
Douglas-fir and ponderosa pine, plant	*(73)* 20 201	— 	20 201	9.95
Douglas-fir and ponderosa pine, precommercial thin and release	*(74)* 20 81	— 	20 81	24.69
All types, plant	— 	*(75)* 7 59	7 59	11.86
Douglas-fir and ponderosa pine, precommercial thin and release	— 	*(76)* 18 106	18 106	16.98
Rocky Mountains residual	— 	*(77)* 14 51	14 51	27.45
Total	40 282	39 216	79 498	15.86
Percent sampled	14.18	18.06	15.86	—

[1]*The three numbers in each block are the sample cell number (in italics), the number of samples, and the number of cases in the population.*
[2]*The state total includes the "other" and the "residual" samples in the state.*
[3]*The Missouri total includes the "North" and "South" samples.*
[4]*The total column adds down, but does not add across.*
[5]*The South total and the North total do not include the Eastern residual.*

Marginal Analysis Format

The study objectives call for comparisons of the financial return and yield increase associated with the FIP investment against what would be expected in the absence of FIP on that tract. Since no immediate yield increases occurred as the result of the initial FIP practice, assumptions about two complete management regimes were required:

intense regime: a set of actions starting with one FIP practice and followed by a sequence of relatively intense but practical practices and harvest, and

current regime: a sequence of actions characteristic of what typical nonindustrial private landowners are now applying.

All yield and mean annual increment (MAI) increases are estimated from the difference or the interval between these two regimes (figure 2). Both regimes are carried to a second rotation which is then repeated in perpetuity in order to standardize the time horizons of competing investments. The financial returns are estimated from the interval between these two perpetual series. Any costs or returns that are of the same magnitude and occur at the same time in both the intense and current regimes cancel each other out. For this reason land costs can be ignored. Annual management costs were also excluded, although they may be slightly higher in the intense regime. Taxes were excluded because they have no impact upon the productivity of the investments.

This study estimates the return and yield increase likely from sample FIP investments as they were actually installed, assuming they are followed by a sequence of practices of an intensity commensurate with the initial treatment. This estimates whether the marginal FIP investment which was actually installed will be "productive." The study does not attempt to determine whether the treated acreage should be used for timber production or not, nor whether the level of management intensity reflected by the FIP practice is the optimum intensity for that site and stand condition.

Assumptions about the practices and harvests which follow the initial FIP treatment and the se-

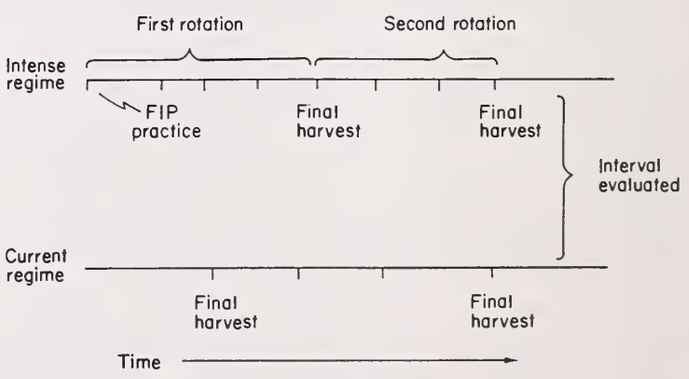

Figure 2.—The basic marginal analysis format.

quence which is assumed for the current regime have a great impact upon the study results. Several alternative sets of assumptions are possible and each has its advantages. The selection of alternative assumptions was judgmental.

One important assumption in the regimes concerns the retention of the practices through final harvest. The ground measurements were made from 1 to 1-1/2 years after the FIP practice was installed, which covers the most crucial plantation survival period. Some plantations were absent at that time because of poor survival, fire, land use changes, or any one of a host of other reasons. For the plantations still intact, however, it was assumed that all will be carried to maturity, i.e., that subsequent retention is 100%. Kurtz et al. (1978) estimates of the retention of ACP tree planting practices in five Eastern states generally run above 90%. Shackelford's (1976) estimates of Soil Bank plantation retention in selected southeastern states are very similar. Williston (1972) found similar retention in Civilian Conservation Corps (CCC) plantations in north Mississippi. Since these studies include losses from the time of planting, the results are quite consistent with the 100% subsequent retention rate assumption beyond age 1-1/2 years.

Williston and Dell (1974) found a lower retention among Yazoo-Little Tallahatchie (Y-LT) plantations in north Mississippi. The lower retention rates in this study may be related to the stronger soil conservation goal of the Y-LT program.

Another important assumption was that complete practice follow-up will occur if sample case conditions indicate that they are needed. This assumption is less certain than the one on 100% subsequent retention. Studies on the current condition of plantations (Kingsley and Mayer 1972, Kurtz et al. 1978, Williston 1972) indicate that follow-up practices are applied less frequently than can be justified silviculturally and financially. Because of these prior studies, special attention was given to identifying 1974 FIP cases that require follow-up treatment, specifying where they are generally located, and indicating what follow-up is required.

The intense regimes were all carried through a "sawtimber" rotation, for example, 30 years for slash pine, 45 years for loblolly pine, and 50 years for longleaf and shortleaf pine. Commercial thinnings were included in all regimes but care was taken to include them only when sufficient thinning volume had accumulated to yield a merchantable harvest. An alternative would have been to carry the plantings to shorter rotations which included no commercial thinnings and was more heavily weighted toward pulpwood production at the expense of sawtimber production. This alternative would generally be consistent with a wider initial seedling spacing than occurred in the 1974 plantings though.

The occurrence of the commercial thinnings is crucial in the financial return calculations. The sensitivity of their presence was tested by assuming that no commercial thinnings will occur. All commercial thinning yields were simply collapsed into the final harvest yield and the financial returns were reestimated.

Ground Measurements

On-the-ground measurements were taken on each of the sample cases 1 to 1-1/2 years after initial treatment to determine the pre- and post-treatment stand conditions. Pretreatment estimates were taken from initial management plans and/or were reconstructed from stump counts or standing dead trees. Standard mensurational procedures were employed using variable radius plots to tally all trees 1 inch in diameter and larger. Fixed radius plots of 6.8 feet were used to tally all trees less than 1 inch.

Plots were systematically located over the entire tract. The number of tally plots varied with tract size as follows:

Tract size (*acres*)	Minimum no. tally plots
less than 10	5 (1 per acre)
10-15	12
16-25	14
more than 25	18

Average pre- and post-treatment stand estimates were derived from the individual tree tally information including the species and respective basal area of the predominant crop species, additional crop tree basal area, and noncrop basal area. The average age, diameter, and height of dominant and codominant trees were estimated, again for both the pre- and post-treatment stand. Site index and site index species were recorded. In plantation cases, the number of surviving planted, volunteer, and free-to-grow seedlings were estimated by species. The type and method of practice application were recorded along with practice intensity for some practices. Sample case reporting forms for a planting and a timber stand improvement case are shown in appendix tables A1 and A2.

The majority of the ground measurements in the East were made by State personnel who measured cases in other states rather than their own to avoid possible bias. For example, the sample plots in Virginia were measured by State personnel from North Carolina. States were seldom handled on a direct reciprocal relationship, but were close enough to insure that the foresters were familiar with the forest types and practices measured. All service forester per-

sonnel were trained by a small group of USDA Forest Service personnel and used the same instructions and measurement procedures to insure consistency. Most of the western plots and some of the eastern plots were measured by USDA Forest Service personnel.

Management Regimes and Yield Estimates

A three-step process was employed to get the management regime and yield estimates for the sample cases. First, the cases were matched up with "stylized" intense and current regimes which covered a relatively broad range of case conditions. Second, information in the cases was compared against a set of "silvicultural thresholds" which defined conditions where the yield increase resulting from the practice will be negligible. If the case failed to pass the threshold test, the yield increase was set to zero. Third, if the case passed the silvicultural threshold test, the regime and yields were adjusted as closely as possible to case-specific conditions. Analysis of 1,433 separate sample cases prohibited the construction of management regimes and yields from scratch for each individual case. A full scope of computerized yield simulators were not available and hand compilations were impractical.

"Stylized" management regimes and yields were developed for both intense and current regimes. The stylized regimes, which covered a relatively broad range of case conditions, were distinguished by species groups, site index ranges, initial treatment categories, and regions. Additional distinguishing labels were used as needed, e.g., for classes of stand age at time of treatment or ranges of stand stocking. Twenty-two separate species groups were identified and are defined in appendix table A3. This approach resulted in 92 separate stylized intense regimes and 48 separate stylized current regimes in the East. A similar approach was used for Douglas-fir and a less structured approach was used for other Western species.

Each stylized regime contains the entire transaction list of subsequent practices that might be needed for cases in the broad area as well as commercial thinnings and final harvests, each recorded by stand age. All regimes follow a clearcut final harvest format, except northern hardwoods in the Lake States which were structured as a selection system on a 12-year cutting cycle. Both the first rotation and the second rotation, repeated in perpetuity, are contained in the same stylized regime. "Optimum" stocking and practice application are assumed in the second rotation of the intense regime. All timber yields are recorded in thousand cubic feet for up to four product groups: softwood timber, softwood pulpwood, hardwood sawtimber, and hardwood pulpwood.

Stylized regimes were developed for four broad practice groups: (1) tree planting, with internal adjustments for plantings on bare land and planting following site preparation; (2) understory release for the removal of overstory trees to release established seedlings in the understory; (3) precommercial thinning restricted to treatments in Southern pine stands younger than 10 years old; and (4) intermediate treatments which covered any treatments of stands between 10 years of age and the maximum age in the silvicultural thresholds. Distinctions between cleanings, cull tree removals, and precommercial thinnings in hardwoods became too fuzzy to retain as separate practice categories and were collapsed into the intermediate treatment class.

These four practice groups are later collapsed into two practice categories for aggregate presentation. The first category is planting, both bare land and site preparation. The second category is timber stand improvement which includes all the nonplanting practices.

Appendix table A4 displays stylized yield examples for both the intense and current regimes, each listed by species group, initial practice, and site index range. The yields are expressed in terms of mean annual increment (MAI) in cubic feet per acre per year. The rotation age and number of commercial thinnings are also shown.

One of the crucial assumptions in the management regimes for conifer plantings is that most of the areas would not have produced a merchantable stand in the absence of the planting. The current regime yields were set to zero. If some minimum number of established volunteer seedlings were counted when the ground measurements were taken, a small yield was assigned to the current rotation. Since the vast majority of the existing Southern pine stands resulted from natural seeding of abandoned farmland, this assumption may seem unduly optimistic for program performance, and harsh toward current yields. This criticism may be true for Southern pine bare land plantings which have an adequate seed source. Measurement of the number of volunteer seedings 1½ years after treatment may not give an accurate picture of seed source adequacy. If a bias does exist, however, bare land plantings of the Southern pines only composed 16% of the total 1974 conifer plantings. Bare-land plantings of red pine and white pine seldom have an adjacent pine seed source and composed only 22% of the 1974 conifer plantings.

In the case of Southern pine site preparation and planting practices, the pretreatment stand usually was an oak-pine or oak-hickory type that was converted to a pine plantation. Although the current management stand would contain volume, it was assumed to be unmerchantable as most of the existing oak-hickory stands on pine sites in the South cur-

rently are. Forty-five percent of the 1974 conifer plantings were such site preparation and plantings of Southern pine.

Once a sample case was matched with appropriate intense and current regimes using the regime labels, certain basic case characteristics were compared against "silvicultural thresholds." The silvicultural thresholds defined situations where yield increase due to the practice is expected to be negligible, either because of the stand that was treated, or the way in which it was treated. The thresholds can be grouped as follows:

1. minimum number of surviving planted seedlings, below which stocking is insufficient to justify carrying the stand to maturity,
2. maximum stand age at time of treatment, beyond which the stand is too close to harvest age to accumulate sufficient growth increase and/or beyond which the trees are not physiologically capable of sufficient response,
3. minimum basal area reduction, below which the stocking level was not reduced enough to induce sufficient growth increase,
4. minimum pretreatment stocking, below which the stand is stocked sparsely enough that removal of additional trees will not significantly affect growing space, and
5. several miscellaneous thresholds, such as removal of suppressed understory trees in northern hardwood stands.

The actual silvicultural thresholds developed for these five groups are shown in table 3. These thresholds were derived from available silvicultural guides and augmented by professional judgment.

Some cases that fail the silvicultural threshold tests will produce a positive yield increase. For example, intermediate treatments of oak-hickory stand over 45 years old may result in a yield increase, especially on high sites. In such hardwood types as oak-hickory or maple-beech-birch, a positive financial return may result because the growth of the post-treatment stand can be concentrated on higher value tree species. Cases that pass the threshold test, however, will yield higher returns, and use of the thresholds forces concentration upon higher return cases.

If a case failed to pass any of these thresholds, it was assigned a net yield increase of zero and a net cost equal to the initial treatment cost. Alternatively, if only part of a sample case exceeded the silvicultural thresholds, the case was split accordingly. For example, if 3 acres of a 10-acre plantation were lost to fire, the 3 acres were thereafter treated as an inadequately stocked parcel while the 7 acres were treated as adequately stocked, each parcel carrying one half of the expansion factor due the whole case. A detailed list of the threshold tests which 1974 cases failed to pass is presented later in this report.

If a sample case passed the threshold tests, basic case characteristics were again examined, this time to adjust the stylized regime and yield as closely as possible to the situation described in that case. The adjustment factors can be grouped into 5 classes: stocking adjustments, stand age adjustments, situations which remove follow-up practices, site index adjustments, and miscellaneous adjustments. Examples of adjustments for each of these classes are shown in table 4.

The management regimes and yield estimates were drawn primarily by knowledgable USDA Forest Service FIP program personnel from a wide variety of published and unpublished sources. The regime and yield sources consulted are listed by species group in the appendix bibliography. Professional opinion was often required to interpret and extrapolate the published results, especially in the development of the yield adjustment factors. Computerization of the entire case-by-case regime and yield estimating process helped greatly in insuring consistency among these judgments.

A surprisingly small amount of yield data was found for some species groups and practices. The lack of yield response data for intermediate treatments in 10 to 30 year old southern pine, oak-pine stands, and various northern conifer stands was particularly unfortunate since these are the short horizon-low investment practices to which nonindustrial private landowners are often most receptive (Anderson 1975). It was also difficult to find data on which to base the adjustment factors.

Because of the inevitable concern over the accuracy of the yield estimates, the sensitivity of each case's internal rate of return (IROR) to changes in yields was measured. The sensitivity to commercial thinning yields was measured separately from final harvest yields. The results measure how much of a percentage change in yields is necessary to change the case's IROR by 1% point of interest, e.g., from an IROR of 7.5% to 6.5%. Similar sensitivity results were derived for the estimates of stumpage price and the subsequent treatment costs. Sensitivity results were averaged by sample cell for all cases with nonzero IROR's and are tabulated in appendix table A10. Sample regimes for a planting and timber stand improvement case are shown in appendix tables A5 and A6.

Stumpage Price Estimates

The same philosophy used in developing regimes and yields was used in estimating the necessary stumpage price estimates. This started with "stylized" current stumpage prices by region and species. The

Table 3. Silvicultural thresholds used to identify stand and practice conditions that are likely to result in negligible growth increase

I. Timber stand improvement

Species	Practice	Maximum age	Minimum basal area reduction	Minimum pretreatment basal area
		(years)		
1. Southern pine[1]	Intermediate treatment	40	10 sq. ft.	0-3" DBH, 300 trees 4-6" 20 sq. ft. 7-10" 30 sq. ft. 11 + " 40 sq. ft.
2. Oak-pine	Intermediate treatment	45	15%	B-level stocking[2]
3. Oak-hickory	Intermediate treatment	45	15%	B-level stocking[2]
4. Cove hardwood	Intermediate treatment	60	15%	B-level stocking for oak-hickory[2]
5. Black walnut	Intermediate treatment	60	—	—
6. Black walnut	Prune	60	—	—
7. Northern hardwood (Northeast)	Intermediate treatment	60	10 sq. ft.	B-level stocking[2]
8. White birch	Intermediate treatment	45	10 sq. ft.	B-level stocking[2]
9. Northern pine	Intermediate treatment	60	15%	B-level stocking[2]
10. White pine	Prune	60	—	—
11. Red pine	Prune	60	—	—
12. Spruce-fir	Intermediate treatment	50	20 sq. ft.	B-level stocking[2]
13. Hemlock	Intermediate treatment	60	15%	B-level stocking for white pine[2]
14. Douglas-fir	Intermediate treatment	60[3]		
15. Ponderosa pine	Intermediate treatment	60[3]		

II. Planting and understory release

Species	Minimum surviving planted or established seedlings
	(No./acre)
1. Southern pine[4]	200
2. White pine	200
3. Red pine	150
4. Jack pine	200
5. Spruce	200
6. Douglas-fir	150-300[5]
7. Ponderosa pine	250-300[5]

III. Miscellaneous practices

1. Removal of understory trees only in oak-hickory, cove hardwood, northern hardwood, or white birch intermediate treatments.
2. Removal of grape vines only in oak-hickory or cove hardwood stands more than 7 years before final harvest.

[1]*Except for slash pine which has a maximum age of 20 years and Virginia pine which has a 10 year maximum age.*

[2]*The B-level stocking in the respective stocking guide which indicates the minimum basal area required, by diameter class, to achieve full stocking.*

[3]*The maximum age threshold was augmented with field observer comments on other stand characteristics.*

[4]*Except for Virginia pine which has a 250 tree threshold.*

[5]*Varied by region.*

stumpage prices for each case were estimated by weighting the species prices together with case-specific information to reflect the species composition and region where that case occurred. Assumptions about future rates of real price increase were then applied to these current stumpage price estimates in order to estimate prices at the time the timber would be harvested.

Because of the significant impact of species upon stumpage price, separate stylized prices were compiled for 17 softwood, 23 hardwood, and 3 special pruned species in the East, and for 10 softwood species in the West. Since final product suitability has a major impact upon stumpage prices, separate prices were also compiled for sawtimber and pulpwood stumpage by the separate species.

Table 4. Examples of adjustment factors used to move the stylized regimes closer to case-specific situations

Adjustment class	Example
1. Stocking adjustments:	a. slash pine, plantation: if number of surviving planted seedlings is 200-299, remove first commercial thin and reduce yield of second by 10 percent.
	b. oak-hickory, intermediate treatment: if post-treatment basal area is 10-29 sq. ft. and stand age is 0-24 yr., reduce all yields 10 percent.
	c. loblolly pine, understory release: if residual basal area is 20-29 sq. ft., reduce final harvest yields 8 percent.
2. Age adjustments:	a. oak-hickory, intermediate treatments, if the post-treatment stand age is 40-45 yr., reduce the first commercial thinning yields 53 percent, the second 43 percent, the third 28 percent, and the final harvest 11 percent.
3. Practice removal:	a. loblolly pine, plantation: if the number of surviving planted is 300-399 and the number of free-to-grow hardwood seedlings is less than 300, remove the hardwood control treatment.
4. Site index adjustments:	a. northern hardwoods, intermediate treatments: if the site index is 65-74, rather than 55-64 as the stylized is, increase final harvest yields 15 percent.
5. Miscellaneous adjustments:	a. planting genetically improved slash pine: increase all yields 15 percent.
	b. "less intense" site preparation or planting on bare land: reduce all yields on loblolly cases 20 percent and on slash pine cases 10 percent.

Prices also differ by region because of correlation with factors such as competition, terrain, accessibility, and tree quality. Therefore, the stylized stumpage prices were developed for 13 regions in the East (fig. 3) and for 5 regions in the West. The western regions correspond to USDA Forest Service administrative regions 1, 2, 3, 5, and 6. These stylized stumpage prices, computed in dollars per thousand cubic feet to match the timber yield estimates, are arranged in appendix table A7.

The stylized prices were drawn from the published and unpublished sources listed in the appendix bibliography. Just as with the yield data, some empty data cells were filled by linkage to and extrapolation from prices in neighboring regions. The price estimates were set equal to the midpoint of the published stumpage price range or the median price if it was reported.

Special product potentials were considered in setting the prices. For example, 50% of the longleaf pine sawtimber and pulpwood volume was priced at a medium pole grade.[2] This accounts for the price differences between longleaf and the other major pines. Similarly, 4% of the white oak, 15 to 25% of the yellow birch, and 4% of the sugar maple sawtimber stumpage[3] was priced as median grade veneer. Twenty percent of the walnut sawtimber volume in natural stands and 90% of the walnut in plantations was priced as veneer. The median sawtimber prices and the special product prices were weighted together by their respective volume percentages.

[2]*Personal communications with Richard Welch, Southeastern Forest Experiment Station, Asheville, N.C., and William Balmer, Southeastern Area, Atlanta, Ga., USDA Forest Service.*

[3]*Personal communication with James Bones, Northeastern Forest Experiment Station, Upper Darby, Pa., Burton Essex, North Central Forest Experiment Station, St. Paul, Minn., and Burl Ashley, Northeastern Area, Morgantown, W. Va., USDA Forest Service.*

The stylized prices per unit were the same for both pre- and post-treatment yields in all situations except hardwood sawtimber. One impact of intermediate treatments in hardwoods is upon the average tree grade. Removing lower quality trees raises the average grade of the residual stand, and the residual stems put on more diameter growth following treatment which is closely related to tree grade. These grade differences influence product potential which in turn is reflected in higher stumpage prices that the discerning landowner can capture. The post-treatment hardwood sawtimber prices are therefore generally higher than the pretreatment prices by 15% to 25%, the actual amount varying by species and region (appendix table A8). These percentages were calculated from the reported price ranges and they raise the prices to a point halfway between the midpoint and top end of the price range.

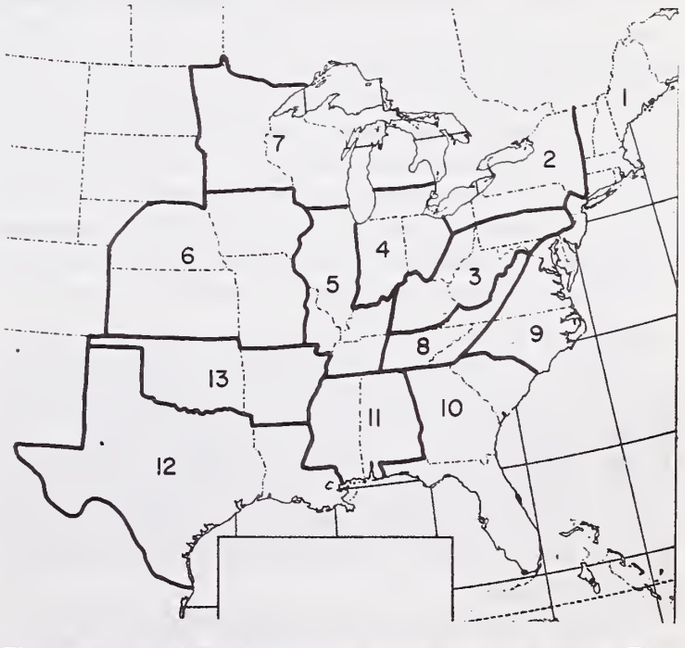

Figure 3.—Stylized stumpage price regions in the East.

The stylized stumpage prices were calculated as the simple average of prices for 1971-72-73 when the data was available. The average price for the base period was updated to 1974 by the All Commodity WPI.

Case-specific stumpage prices for the four product groups shown in the management regimes — softwood sawtimber, softwood pulpwood, hardwood sawtimber, and hardwood pulpwood — were derived by weighting stylized prices by information available in each sample case. The prices for cases that start with an intermediate treatment are derived through a weighting of the prices for crop species listed as present on each case by the basal area of the species, respectively:

$$PR_j = \frac{\Sigma(SPR_{ij} * BA_i)}{\Sigma BA_i}$$

where:

PR_j = the price per thousand cubic feet for product group j

SPR_{ij} = the stylized price for product j of species $_i$

BA_i = the crop tree basal area for species $_i$ for that case.

The price for the current regime yields are derived from the pretreatment prices by species and pretreatment crop tree basal areas. The intense regime prices weight the post-treatment prices by species by the post-treatment crop species basal area. Therefore, changes in the species composition of the stand brought about by the treatment are reflected in the stumpage prices. This species weighting of prices is very important in hardwood stands where one of the most important impacts of the treatment is in changing the species composition toward higher valued species.

The same approach was used to derive the stumpage prices for plantation yields except that the stylized species prices were weighted by the number of surviving planted seedlings by species rather than crop tree basal area. In precommercial thinning and understory release cases, the price is set equal to the price of the predominant species listed for the case. These same case-specific stumpage price estimates were used in the second rotation in most cases, therefore assuming that the second rotation species composition would be the same.

Only crop species are considered in estimating the price for sample cases and crop species generally have higher prices than the average price of all species present in the stand. The same approach is used in both the intense and current regimes, however, so any bias this presents is small when the incremental yield change is evaluated under the marginal analysis format.

The calculations and price data described to this point provide case-specific stumpage price estimates for 1974. When applied in the financial return calculations, prices are required for the year in which the harvest occurs. There is some evidence that real stumpage prices have risen over time and may continue to do so in the future. Therefore, it was necessary to make assumptions about the future annual rate of real stumpage price changes.

Row (1973) developed regressions equations that estimated the historical rate of real price increases in southern pine sawtimber stumpage using annual data between 1910-70 and between 1947-70. Three of his four estimates were quite close and averaged 1.6% per year. The historical rate of real pulpwood price increases in the East from the 1950-73 data reported by Phelps (1973) are much lower except for softwood pulpwood in the Southeast, which was only slightly lower than Row's 1.6%.

As for future increases, the USDA Forest Service's (1973) timber supply and demand analysis predicts a doubling of real softwood sawtimber prices between 1970 and 2000. This gives an average annual rate of increase of 2.1% per year. Adams[4] prepared "trend level" estimates of future real stumpage prices between 1976 and 2030. The rates of increase between the 1976-78 and 2027-30 mean prices of those trend series ranged from 1.5% to 2.6%, depending on regions and species group.

Based upon this accumulated evidence, the annual rates of real stumpage price increase for both sawtimber and pulpwood assumed in the evaluation of the FIP sample cases were:

Stumpage category	Annual increase *(percent)*
Eastern softwoods	1.5
Eastern hardwoods	2.5
Western softwoods	2.5

These rates were employed in the financial return calculation as described by Goforth and Mills (1976).

These historical East and West differentials in real stumpage price increase cannot continue indefinitely. The lower eastern stumpage prices will eventually draw more primary product production capacity into the East, especially the southern portion, which will raise the eastern stumpage prices. The differential increases may roughly continue for 30 to 45 years, however, which covers the first rotation of the Southern pine practices. Sensitivity analysis on the second and subsequent rotations indicates that they have little impact upon the estimated financial return anyway. There is a direct and simple relationship between the IROR and the rate of real price increase assumed in the calculation of the IROR, which should ease major concern about this assumption. There is essentially a direct additive relationship. For

[4]*Personal communication with Darius Adams, Oregon State University, Corvallis.*

example, if a case has an IROR of 4.5% when the annual rate of real price increase is assumed to be 1.5%, the same case will have an IROR of approximately 5.0% if the real price increase assumption is changed to 2.0%. Therefore, the impact upon study results to changes in this assumption are quite easy to estimate.

Treatment Cost Estimates

Two groups of treatment cost data were needed to estimate the financial return of each sample case, one for initial treatment cost and one for the cost of any subsequent treatments in the regime. The cost of the initial FIP practice which starts the schedule of transactions in the intense regime is the largest and most important cost from the point of influencing financial returns. Since the FIP practice had already been applied, the federal funds expended and the cost-share percentage were a matter of record. The direct treatment cost of the FIP practice, both the private and federal share, were calculated from this data.

A program delivery or "overhead" cost per case was also calculated. The delivery cost includes all chargeable ASCS county office costs as estimated from an analysis of 1976 program year costs (USDA-ASCS 1977). The service forester's assistance time was included as estimated from time spent in Cooperative Forest Management (CFM) assists (USDA-FS 1976). Program delivery must also absorb a certain amount of "slippage" cost from cases that were assisted under FIP but for a host of reasons were never cost-shared. In 1976-77 the slippage rate was about 30%.[5] The resulting program delivery cost was $223 per case. Washington Office and Regional Office program delivery costs that amount to roughly $300,000 per year for the Forest Service and Agricultural Stabilization and Conservation Service were not included in this $223 figure.

Four constructs of the initial FIP practice cost were developed from this information which include:

1. direct cost: federal plus private direct cost-share.
2. total cost: direct cost plus per case program delivery cost.
3. public cost: federal direct cost plus per case program delivery cost.
4. private cost: private direct cost only.

The financial return of each case was estimated under each of these four versions of initial cost. Most of the results are displayed under the direct cost option, since it puts the initial cost on the same footing with subsequent treatment costs. The financial results under the public and private cost options provide some insight on the incidence of costs and returns. Investment efficiency is the major focus of this study rather than the distribution question, however. Taxes in the intense and current regimes largely cancel each other out.

The second group of cost data is for the treatments in the regimes which follow the initial FIP practice. For example, an estimate of the cost of precommercial thinning in an overstocked stand was required.

Adjusting "stylized" data for case-specific situations was also attempted here to get subsequent treatment costs, but failed. Equations that predict silvicultural treatment costs as a function of treatment area characteristics such as those developed by Row (1973) are simply not available for the scope of practices encountered in this study.

An effort was made to use the sample FIP cases as a data base for development of treatment cost equations. No significant relationships could be developed between the direct treatment cost and characteristics of the treated area or the treatment itself. Contacts with selected state and federal personnel revealed that the FIP cost-share for each case is often the maximum federal share permitted in the county for that practice irrespective of the cost of treating that particular case. As a result, some cases may receive more cost-share funds and some may receive less funds than are actually needed to achieve the 50 to 75% cost-share rate permitted by law. The method of allocating cost-share to individual cases in 1974 then may have an impact upon financial returns.

Average direct costs were therefore compiled from a number of sources for the subsequent treatments (append. table A9). Costs were varied by regions and species groups where appropriate. Four cost regions were used in the East and separate costs were compiled for each National Forest administrative region in the West. Subsequent treatment costs were unchanged regardless of which initial cost option was used.

The real cost of subsequent treatments was held constant at their 1974 level. All subsequent treatments in the first rotation are small and the second rotation costs are far in the future. The cost of subsequent treatments only has a minor impact upon the estimated financial returns, even if a small real cost increase were assumed. The sensitivity analysis results on data errors shown in table 11 bear this out.

The subsequent treatment cost data was collected from a number of sources. Costs for site preparation and planting, intermediate treatments in hardwoods, and pruning in the East were compiled from 1976 FIP costs and adjusted to 1974 by the All Commodity WPI. Costs for hardwood control by mist blower, prescribed burning, and precommercial thinning[6] in

[5] *Personal communication with Robert Shackelford, Cooperative Forestry, USDA Forest Service, Washington, D.C.*

[6] *Personal communication with James Moak, Mississippi State University, Mississippi State.*

the East were compiled from Moak et al. (1977), Callahan and Smith (1974), and professional judgment of state and federal personnel involved in the delivery of FIP. Costs in the West were derived from Zach (1977) and adjustments of National Forest costs.

Discount Rates

The financial returns of the program are displayed in terms of internal rate of return (IROR), present net worth (PNW), and benefit/cost ratio (B/C). Use of IROR requires some alternative return for comparison and the alternative rate is included in PNW and B/C calculations as the discount rate.

All PNW and B/C calculations were made at each of four different discount rates, in part to test the sensitivity of the study conclusions to the discount rate assumption. First, the Federal Office of Management and Budget (OMB) (1972) requires that public programs, with a few exceptions, be evaluated against a 10% discount rate. OMB estimated that this rate equals the "real . . . rate of return on private investment, before taxes and after inflation." Second, a discount rate of 7-1/2% was used. This is the current "nominal" rate of return, as distinguished from the real rate once inflation has been removed, on longterm government bonds. Third is the 1977 Water Resources Council rate of 6-3/8% (USDA-SCS 1976). The rate for federal water projects is related by law to the nominal rate on longterm government bonds. Fourth, a discount rate of 3% was used. This rate is much lower than the nominal rate on government bonds but it is closer to the real rate on government bonds, given current inflationary expectations, than the three higher discount rates.

Recall that the costs and prices used in the financial return calculations in this study are "real" costs and prices that include real or relative price changes but exclude any inflationary impact of a change in the value of the dollar. The resulting IROR estimates are therefore real rates of return. The FIP investments should then be rated against a "real" alternative rate of return rather than a "nominal" return (Gregersen 1975). The 3% rate might be valid under this approach if the nominal government borrowing rate of 7-1/2% or 6-3/8% were used and an inflationary rate of 4-1/2% or 3-3/8% were assumed, respectively. On the other hand, FIP must compete with other federal programs for dollars, and other natural resource programs are most commonly ranked against a nominal rate of 6-1/2 to 7-1/2%. The most detailed results are presented against the 1977 Water Resources Council rate of 6-3/8%.

Study Results

All results are population estimates for the 1974 program, excluding the small number of miscellaneous practices. Many of the detailed results are presented for both the original sampling scheme stratification shown in table 2 and the detailed practice and species group stratification developed for the stylized management regimes shown in table 5. Sample cases carried the expansion factor based upon the sample strata in which they originated, regardless of any post-stratification.

Practice and Species Composition of the Program

There were 6,230 southern pine cases in the plant bare land, site preparation and planting, and understory release practice categories (table 5). This was 39% of the 1974 program. The vast majority of these southern pine cases (78%) were loblolly pine and a much smaller percentage (17%) were slash pine. Almost all of the slash pine planting occurred in Florida and Georgia. This is indicative of the trend toward loblolly pine planting and away from slash pine planting because of offsite plantings of slash pine in the past. Of these southern pine cases 3% were shortleaf and 1% were Virginia pine, both of which typically have lower returns than loblolly and slash pine.

A large number of southern pine and oak-pine assists were reported as precommercial thinning cases in the first stage evaluation. Data in this study revealed that only 18 cases were treatments in stands less than 10 years old — the class that might be called "true precommercial thinning" cases. Conversely, 511 cases were in stands over 10 years old and were classed as "intermediate treatments" in this study. It was the intermediate treatment practice which was highlighted as largely lacking yield data.

There were 3,767 northern conifer cases in the plant bare land, site preparation and plant, and understory release practices or 24% of all the 1974 cases. There were 60% as many northern conifer cases as there were corresponding southern pine cases and the southern pine cases on the average had larger tract sizes. Red pine contributed 45% of the cases in this class, white pine had 40%, and white spruce contributed 12%.

Intermediate and pruning cases in northern conifer species totalled 1,175 cases or 7% of the 1974 cases. Sixty-four percent of these cases were white pine. Twenty-two percent of the cases were exclusively pruning and 26% had both pruning and an intermediate treatment. Recall that pruned cases had a separate pruned price (appendix table A5) which implies that log grade will have the same relative importance when these stands mature as it does now.

Table 5. Number of sample (italic) and estimated number of population cases in the 1974 program by detailed species and practice categories

Species	Practice							
	Plant bare land	Site preparation and planting	Understory release	Precommercial thin	Intermediate	Prune and intermediate	Prune	Total
Slash pine	*34* 202	*47* 850	*4* 25	*1* 2	*14* 34	—	—	*100* 1113
Longleaf pine	*3* 21	*4* 87	—	—	*6* 18	—	—	*13* 126
Loblolly pine	*158* 1232	*221* 3205	*76* 394	*3* 16	*23* 148	—	—	*481* 4995
Shortleaf pine	*6* 18	*7* 64	*21* 88	—	*23* 168	—	—	*57* 338
Virginia pine	*3* 9	*1* 35	—	—	*4* 50	—	—	*8* 94
Oak-pine	—	—	—	—	*17* 93	—	—	*17* 93
Red pine	*61* 1275	*31* 432	—	—	*3* 39	*8* 69	*36* 180	*139* 1995
White pine	*38* 811	*38* 649	*2* 48	—	*40* 436	*23* 232	*11* 81	*152* 2257
Jack pine	—	*3* 89	—	—	*1* 13	—	—	*4* 102
Spruce-fir	*24* 362	*7* 77	—	—	*8* 86	—	—	*39* 525
Hemlock	—	—	—	—	*5* 39	—	—	*5* 39
Larch	*1* 10	*1* 14	—	—	—	—	—	*2* 24
Oak-hickory	*2* 70	*2* 52	—	—	*128* 1183	*1* 9	—	*133* 1314
Cove hardwood	—	*3* 105	—	—	*21* 346	*1* 4	—	*25* 455
Black walnut	*3* 87	*10* 233	—	—	*19* 190	*6* 155	*4* 78	*42* 743
Northern hardwood	—	—	—	—	*151* 1164	—	—	*151* 1164
White birch	—	—	—	—	*9* 39	—	—	*9* 39
Douglas-fir	*3* 30	*11* 110	—	—	*23* 100	—	—	*37* 240
Ponderosa pine	—	*10* 92	—	—	*22* 116	—	—	*32* 208
Lodgepole pine	—	—	—	—	*6* 24	—	—	*6* 24
Total	*336* 4127	*396* 6094	*103* 555	*4* 18	*523* 4286	*39* 469	*51* 339	*1452* 15888[1]

[1]*The total does not add to the population total in table 1 due to rounding errors in the expansion factors.*

There were 547 hardwood planting cases or 3% of the 1974 program. Over half of these were black walnut plantings and the rest were about evenly split between cove hardwood and oak-hickory species.

Intermediate and pruning cases in the oak-hickory type contributed 1,965 cases to the 1974 program or 12% of the total cases. Of the 1,965 cases, 61% were predominantly oak-hickory, 18% were cove hardwoods, and 21% were predominantly black walnut stands or would be managed as such given a very liberal definition of what constitutes a black walnut stand (append. table A3).

There were 1,164 intermediate treatments in northern hardwoods and 39 in white birch. These constituted 8% of the 1974 cases and 61% as many as there were similar treatments in the oak-hickory type.

Douglas-fir planting contributed 140 cases and intermediate treatments in Douglas-fir and ponderosa pine totalled 216 cases. In total, the West had 472 cases or 3% of the 1974 cases.

In summary, the largest segments of the 1974 program include the planting and release of loblolly pine (30%), planting red pine (11%) and white pine (9%), and planting slash pine (7%). Intermediate treatments in oak-hickory (7%) and northern hardwoods (7%) were also significant. Together these six species-practice groups accounted for 71% of the cases in the 1974 program.

Aggregate Study Results

The aggregate results for the 1974 population include all cases, except the small group of miscellaneous practices, as they were actually installed in 1974. Failure cases as well as successful cases are included. The results also reflect the particular mix of practices, species, sites, and treatment costs actually installed in 1974. It is very important to remember this if any attempt is made to extrapolate 1974 results to other program years.

Under the direct cost option of the initial FIP treatment, the weighted average real IROR was 10.2% (table 6). The average PNW per acre using a 6-3/8% discount rate was $213 and the total B/C ratio, calculated by the sum of the expanded benefits divided by the sum of the expanded costs, was 5.6 at the 6-3/8% rate. Seventy-five percent of the cases were capable of earning the 6-3/8% rate and 67% were capable of earning the 7-1/2% rate. The total PNW of the 1974 program was $54 million at 6-3/8%. The cost of the initial FIP practices was $8.3 million for the direct federal cost-share plus an estimated private cost-share of $3.0 million, plus program delivery cost of approximately $3.8 million dollars. The cost of subsequent treatments must be added to this $15.1 million initial cost to get a total cost estimate.

The average IROR was 9.4% under the total cost option which adds the $223 per case program delivery charge to the direct cost (table 7). The IROR under the total cost option is only 0.8% less than the IROR under the direct cost option. On the other hand, the percentage of cases capable of earning the 6-3/8% rate declines by 16% to 63%. Fifty-three percent of the cases can earn 7-1/2%.

The $223 per case program delivery cost is only one factor that influences the economics of scale of silvicultural treatments. Row (1973), for example, also includes direct treatment cost and stumpage price variations by tract size. Even with the program delivery cost alone, however, the IROR under the total cost option is significantly lower than under the direct cost option for small tract size cases. The average IROR for all timber stand improvement treatments 1 to 9 acres in size declines by 30% when the program delivery cost is added to the direct cost (figure 4). The IROR impact is smaller on planting cases because direct planting costs are higher but even there the IROR for 1 to 9 acre tracts declines 18%. The majority of the delivery cost impact upon IROR is dissipated once tract sizes reach 20 acres.

The average IROR under the federal cost option is 10.2% (table 8) and under the private cost option which includes only the private share of the direct cost is 14.9 percent (table 9).

The total yield increase expected during the first rotation is estimated to be 1.04 billion cubic feet

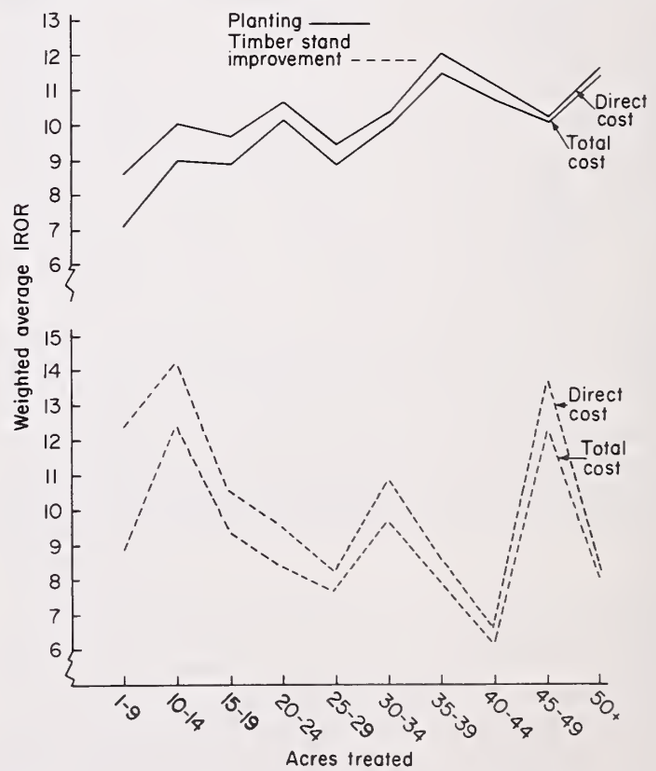

Figure 4.—Weighted average internal rate of return tract size for planting and timber stand improvement cases, by cost option and tract size.

Table 6. Aggregate financial return results under the direct cost option of the FIP treatment

Discount rate	Total PNW	Average PNW	Total B/C ratio	Cases earning discount rate
(percent)	*(mil. dollars)*	*($/acre)*		*(percent)*
10	7.94	31.40	1.9	45
7-1/2	30.96	122.41	3.6	67
6-3/8	53.96	213.37	5.6	75
3	605.81	2,395.45	54.2	83
(weighted average IROR = 10.2)				

Table 7. Aggregate financial return results under the total cost option of the FIP treatment

Discount rate	Total PNW	Average PNW	Total B/C ratio	Cases earning discount rate
(percent)	*(mil. dollars)*	*($/acre)*		*(percent)*
10	4.42	17.47	0.9	32
7-1/2	27.43	108.48	1.9	53
6-3/8	50.44	199.45	3.0	63
3	602.29	2,381.70	31.8	82
(weighted average IROR = 9.4)				

Table 8. Aggregate financial return results under the public cost option of the FIP treatment

Discount rate	Total PNW	Average PNW	Total B/C ratio	Cases earning discount rate
(percent)	*(mil. dollars)*	*($/acre)*		*(percent)*
10	7.56	29.89	1.0	39
7-1/2	30.58	120.90	2.2	57
6-3/8	53.58	211.86	3.5	65
3	605.43	2,393.94	36.0	82
(weighted average IROR = 10.2)				

Table 9. Aggregate financial return results under the private cost option of the FIP treatment

Discount rate	Total PNW	Average PNW	Total B/C ratio	Cases earning discount rate
(percent)	*(mil. dollars)*	*($/acre)*		*(percent)*
10	16.09	63.62	5.3	69
7-1/2	39.10	154.62	10.9	79
6-3/8	62.11	245.58	16.0	82
3	613.96	2,427.66	114.9	83
(weighted average IROR = 14.9)				

Table 10. Estimated first rotation yield increase, in million cubic feet, by product and year

	Softwoods		Hardwoods		
Year	Sawtimber	Pulpwood	Sawtimber	Pulpwood	Total
		(million cubic feet)			
1974-2000	3.3	98.1	8.3	10.4	120.1
2001-2025	368.8	199.2	14.6	8.4	590.9
2026-2050	81.4	1.0	33.4	-10.1	105.8
2051-2075	71.8	-1.7	1.3	0.9	72.3
2076-2100	154.4	0.0	-0.1	0.5	154.8
Total	679.7	296.7	57.4	10.1	1043.9

(table 10). The majority of this yield is softwood sawtimber (65%) and softwood pulpwood accounts for most of the rest (28%). Hardwoods account for a much smaller yield increase. This is in keeping with the observation that intermediate treatments in hardwoods primarily affect tree quality and species composition, not total yield. Hardwood treatments were also a relatively small component of the program. The average increases in mean annual increment (MAI) in cubic feet/acre/year are:

Product	MAI increase
softwood sawtimber	44.01
softwood pulpwood	26.93
hardwood sawtimber	2.44
hardwood pulpwood	0.44
total	73.82

The first rotation yield increases are spread over a 125-year period, from 1974 to 2100. A very large share (40%) of the softwood sawtimber yield increase is expected to occur between 2020 and 2025 when the loblolly pine plantations mature. Over half (55%) of the softwood sawtimber yield increase occurs within 50 years of the initial investment. Twelve percent occurs between 51 and 75 years after 1974 and 11% occurs in the final 25-year period. Twenty-three percent occurs 100 to 125 years after initial investment when the northern pine plantations mature. The softwood pulpwood yield increase generally occurs earlier, 33% in the first 25 years and 67% in the next 25 years. Most of the pulpwood yield comes in commercial thinnings while the majority of the sawtimber yields are not achieved until final harvest.

Forty-two percent of the hardwood sawtimber yield occurs in the first two 25-year periods. The remaining 58% of the hardwood sawtimber yield occurs between 51 to 75 years following the initial investment.

Roughly 0.1% of the nonindustrial private commercial timberland was treated under the 1974 FIP program. Although the softwood yield increases from the first rotation are spread over a 125-year period, their sum equals 28% of the total nonindustrial private softwood removals from growing stock in 1970 (USDA-FS 1973). The average softwood rotation in the 1974 FIP cases was 54 years. The average first rotation softwood yield increase for all the cases was 3.86 thousand cubic feet per acre.

Assuming that a similar 0.1% could be treated each of the 54 years, and assuming that their total output equals the 1974 level on the average, 28% of the annual softwood growing stock removals in this class could be derived each year from 5.4% of the nonindustrial private acreage. Carried one step further, if enough similar acres could be located, management of 19% of the nonindustrial private acreage would produce an average annual yield increase equal to the total 1970 removals from this owner class. This small percentage is not surprising given that the majority of the softwood yield on nonindustrial private lands currently come from natural stands where the pines must compete with hardwoods, while the FIP cases are heavily weighted toward plantations on bare land or those following conversion.

This means that intensive culture on a relatively small percentage of the total acres could produce as much yield increase as is currently being produced from the total commercial timberland base. These conclusions are similar to those reached by Vaux (1973) for California. Intensive culture of a larger percentage of the acreage could produce more output and a significant percentage of the acreage would still be free for nontimber management objectives.

Sensitivity of Aggregate Results to Changes in Data and Assumptions

The sensitivity of the IROR in each sample case to changes in data input was measured. Sensitivity was measured by determining how much of a percentage change in selected groups of data was necessary to change the IROR of each case by 1 percentage point of interest, e.g., from 6.4% return to 5.4% or 7.4%. Sensitivity to changes in each of four data groups was measured independently; subsequent treatment costs, commercial thinning yields, final harvest yields, and stumpage prices. Only data in the first rotation of the intense regime was subjected to the sensitivity analysis. If the sensitivity of the same data items in the intense and current regimes had been tested jointly, the sensitivity would be much lower since the errors tend to compensate for each other. The computer program developed by Goforth and Mills (1975) was used to measure the sensitivity and can be found in more detail in Mills et al. (1976).

The simple average of percentage data changes for individual sample cases with non-zero IROR's was calculated for each of the 77 sample cells or strata (append. table A10). The sensitivity results were further summarized by determining how many cells had average sensitivity levels between certain bounds or percentage data change (table 11).

The sensitivity to errors in the subsequent treatment cost data is very low. The subsequent treatment cost estimates would have to be decreased on the average by 200% in most cells before the IROR is increased by 1% of interest. That is, the cost estimate would actually have to change signs. There is also low sensitivity to errors in the final harvest yield values. In 60 of the sample cells, final harvest yields would have to be increased by more than 100% before the IROR rises 1% of interest.

The financial return results are more sensitive to the commercial thinnings yields, even though they generally produce less yield, largely because they occur earlier in the regime than the final harvests. Even with the commercial thinnings, though, in 57 of the 75 cells that contained thinnings, the yields would have to be increased at least 25% on the average to raise the IROR by 1% of interest.

Table 11. Number of sample cells with data sensitivity levels between certain bounds of percentage data change, by data group

Percentage data change[1]	Subsequent treatment costs[2]	Commercial thinning yields	Final harvest yields	Stumpage prices
0-9	—	3	—	2
10-24	—	15	1	28
25-49	—	26	1	32
50-99	—	24	15	13
100-199	4	6	23	1
200 +	48	1	37	1

[1]*Average percentage change of data within cases in a sample cell necessary to increase IROR by 1 percent of interest. For example, in three of the sample cells, the commercial thinning yield estimates had to be changed by 0-9% in order to raise the IROR by 1% of interest.*

[2]*The percentage changes are negative for the cost class.*

The most sensitive of the data tested is the stumpage price data. In 30 of the cells, a data error of less than 25% would change the IROR by the specified sensitivity level. The highest sensitivity areas are largely intermediate treatment cases (append. table A10). Even with stumpage price data, however, in 47 of the cells the price estimates would have to be raised more than 25% before the IROR would increase 1% of interest. In summary, there appear to be few situations where potential data errors could materially affect the financial return results. Estimated financial return is more sensitive to the initial cost than to any of the other data items (Mills et al. 1976). Sensitivity of the initial cost was not measured, however, since it had already been expended.

The impact of changing three basic assumptions in the analysis procedures was also tested. First, as shown in the yield information in appendix table A4, the softwood plantation regimes contain from 0 to 4 commercial thinnings and the hardwood intermediate treatment regimes contain from 0 to 5 commercial thinnings. Although thinnings were not included unless they contained merchantable volumes, there are widely varying opinions about their desirability.

A simple test of the impact of the thinning assumption was made by accumulating all commercial thinning volumes into the final harvest without reducing the total rotation harvest volume or changing the rotation length. Under the direct cost option, this reduced the weighted average IROR of all cases in the 1974 eastern population from 10.3% to 7.9%, a reduction of approximately one-fourth. Perhaps more significantly, only 58% of the cases could earn 6-3/8% when thinnings were removed versus 76% when the thinnings were retained. Although it is felt that the thinnings included are silviculturally and economically practical, this points up the necessity of follow-up assistance to these owners to insure that the thinning yields are marketed. Although the previously discussed analysis of data sensitivity indicates that the actual thinning volume achieved can fluctuate some without significantly influencing IROR, this assumption test shows that the thinning *must* take place to gain the estimated returns.

Second, the assumed increase in post-treatment stumpage prices to reflect tree quality impacts of the treatment was tested. The increase of post-treatment prices was removed so the pre- and post-treatment prices were the same by species. Price changes reflective of species composition changes were retained. Again using the eastern population as a test, the weighted average IROR only declined from 10.3% to 10.2%. The greatest impact of removing this assumption was on northern hardwood cases where the weighted average IROR declined from 15.0% to 13.3%.

Last, the second and perpetual rotations of both the intense and current regimes were removed, leaving only the first rotation of each. This was tested in five representative sample cells (cells 11, 25, 39, 50, and 55). The weighted average IROR changed by less than 0.1 percentage point of interest.

The perpetual rotations permit a "clean" financial return comparison with similar time horizons but it is an unnecessary refinement for these timber investments.

Regional and Broad Practice Group Results

The estimates of MAI increase and percentage of cases that can earn 6-3/8% and 7-1/2% differ quite a bit by region. The major financial return and yield indicators of performance were higher in the South than in any other region and 66% of the federal cost-share funds were expended in the South in 1974 (table 12). The average IROR was 10.8% and the average per acre MAI increase was 94 cubic feet. Eighty-eight percent of the cases could earn 6-3/8%.

The average IROR in the North was lower, 8.9%, and so was the average per acre MAI increase, 42 cubic feet. The smaller yield increase is related to the larger proportion of hardwood investments. In the North 66% of the cases could earn 6-3/8%, down 22% from the South.

Table 12. Financial return and yield results by region under the direct cost option

Region	Average IROR	Average MAI increase	Cases earning discount rate		Percentage of total funds
			6-3/8%	7-1/2%	
	(percent)	*(cubic feet/acre)*	*(percent)*		*(percent)*
South	10.8	94	88	86	66
North	8.9	42	66	52	29
Pacific Coast	9.4	67	61	58	3
Rocky Mountains	2.9	2	12	7	2

The average IROR in the Pacific Coast was 9.4% and the average per acre MAI increase was 67 cubic feet, both of which are between those of the North and South. Although the Pacific Coast average IROR was greater than in the North, 5% less (or 61%) of the cases were capable of earning 6-3/8%.

The average IROR in the Rocky Mountains was 2.9%. The other indicators of timber yield and financial return performance were also relatively lower than for the South, North, and Pacific Coast. Only 2% of the 1976 federal funds were spent in the Rocky Mountains, however, so the total program impact was small.

Of the states sampled individually, New York had the highest average IROR (20.0%) under the direct cost option, followed by Indiana (14.6%), Louisiana (14.1%), Florida (12.6%), and Georgia (12.3%) (append. table A11). Several other Southern states had average IROR's above 10%.

The variations in average IROR by state are largely reflective of the sites treated, the mix of practices applied, and regional stumpage price differentials. The average IROR from the southern pine plantings was 11.3% or almost twice as high as the average IROR on northern conifer plantings (6.9%) and over twice as great as the IROR of western conifer plantings (5.0%) (table 13). The percentage of the cases capable of earning 6-3/8% varied similarly. Ninety-one percent of the southern pine plantings, 63% of the northern conifer plantings, but only 47% of the western conifer plantings, could earn the target rate.

The northern conifer plantings do have a larger MAI increase (122 cubic feet) than the southern pine plantings (108 cubic feet). The northern conifers, especially white and red pine, are capable of maintaining a high periodic growth longer than the southern pines which gives rise to the relatively large first rotation yield in the northern conifer plantings. The financial returns are lower in spite of this growth characteristic because fewer northern conifer plantations had the minimum acceptable stocking levels, the MAI peaks at an older age than for southern pine, and the pine stumpage prices in the regions where northern conifers were planted are not as high as where southern pines were planted.

The hardwood plantings had a high average IROR (10.2%). The management regimes required to achieve this return are quite intense, however, requiring several subsequent cultural operations. If those subsequent practices are not installed, the financial return picture will be much different.

The average IROR for timber stand improvements in southern pine and oak-pine and in northern conifers are essentially the same (9.3 and 9.4%). The returns on timber stand improvements of western conifers are lower (7.3%), largely because fewer cases passed the silvicultural thresholds. The per acre MAI increase for the conifer timber stand improvements are much less than for the plantings — 45 cubic feet for southern pines and oak-pine, 25 cubic feet for northern conifers, and 16 cubic feet for western conifers. The yield increase is smaller because the current regime of timber stand improvement cases contains the unmanaged yield of an existing stand. The current regime in most planting cases has negligible yield or largely unmerchantable species.

Timber stand improvements in the cove hardwood and black walnut cases had the highest average IROR of any of the broad practice groups (21.4%). The northern hardwood cases are also high (15.0%). Only a small amount of this high IROR can be attributed to yield increase. The average MAI increases for the two species groups are only 16 and 10 cubic feet, respectively. Although some can be attributed to the assumption of tree quality increase due to the treatment as reflected through stumpage price, when the assumption was removed the average IROR of the northern hardwood cases only fell to 13.3% and the cove hardwood and black walnut fell even less to 20.8%.

Two main factors contribute to these high returns. First, the stumpage price assumptions for the predominant species are high enough that a small yield increase is sufficient. Second, and most important, is the species composition impact of the treatment. Although the post-treatment yield might only be slightly larger than pretreatment yield, it is generally dominated by higher value species. The species composition impact of hardwood timber stand improvements is often ignored in studies of treatment potentials, which leads to an underestimate of potential returns. On the other hand, the impact of the species

Table 13. Financial return and yield results by broad practice groups under the direct cost option

Species group and practice	Average IROR	Total B/C ratio @ 6-3/8%	Total PNW @ 6-3/8%	Cases earning 6-3/8%	Average MAI increase	Total yield increase: Sawtimber	Total yield increase: Pulpwood
	(percent)		(mil. dollars)	(percent)	(cu. ft./ ac./yr.)	(million cubic feet)	
Southern pine, plantings	11.3	4.6	29.31	91	108.1	320.1	229.8
Southern pine and oak-pine, timber stand improvement	9.3	4.3	4.25	73	45.4	45.2	33.4
Northern conifer, plantings	6.9	1.4	0.66	63	122.5	298.1	27.9
Northern conifer, timber stand improvement	9.4	1.8	0.57	76	24.6	13.5	3.7
Hardwood, planting	10.2	26.8	6.13	70	44.0	6.1	2.0
Oak-hickory, timber stand improvement	4.7	1.6	0.72	42	9.5	25.6	2.4
Black walnut & cove hardwood, timber stand improvement	21.4	25.7	7.98	80	16.3	10.9	0.2
Northern hardwood, timber stand improvement	15.0	5.9	2.75	80	10.4		4.6
Western conifers, planting	5.0	4.6	1.01	47	67.1	2.3	2.4
Western conifers, timber stand improvement	7.3	2.2	0.58	33	15.6	2.6	0.5
Total, all species and practices	10.2	5.6	53.96	74	74.8	737.8	306.8

composition change is a function of differential stumpage prices by species.

The same stumpage price differentials by species which occur now are assumed to occur at the time of harvest in the treated hardwood stands. If this price differential does not continue or if the price differential changes by species, the hardwood timber stand improvements will have much lower returns. The price differentials are largely influenced by consumer preferences for products like furniture. The future hardwood prices, and the estimated returns, are more uncertain than the softwood prices.

The average IROR for oak-hickory timber stand improvements is lower than for any other broad practice group (4.7%). The MAI increase is lowest (10 cubic feet) and so is the percentage of the cases capable of earning 6-3/8% (42%). The lower performance resulted from a large number of cases exceeding the silvicultural thresholds, especially the one for maximum stand age. The average IROR of oak-hickory cases that do pass the silvicultural thresholds, however, is about 10%, again reflecting the low treatment cost and species composition impact of the treatment. The same tabulation of results under the total cost option is contained in appendix table A12.

Relatively High and Low Performance Program Segments

Three indicators of timber production performance were used to determine the performance of program segments: the weighted average IROR with respect to the 6-3/8% return criterion, the percentage of cases capable of earning 6-3/8% return, and the average per acre MAI increase relative to the average for the 1974 program. Only large program segments were rated against these indicators unless the segment was isolated enough to permit easy program modification. Financial return criteria were generally given more weight than physical timber yield increase in this ranking. Study results are shown in table 5, and appendix tables A13, A14, and A3.

Loblolly pine plantings ranked highest with respect to these three characteristics. These plantings had an above average IROR and MAI increase. Ninety-three percent of the cases can earn 6-3/8%. Slash pine plantings also ranked high. Their average IROR is higher but the MAI increase and percentage of cases earning 6-3/8% are lower than for loblolly pine plantings. Loblolly pine understory release cases (release of an established understory from overstory competition) constitute a smaller part of the program but their returns are high. The percentage of cases capable of earning 6-3/8% is higher than for any other program segment (97%).

Some of these southern pine planting cases have enough hardwood invasion to require a subsequent hardwood control treatment. Similarly, many of the understory release cases are overstocked such that the management regimes include a subsequent precommercial thinning. If these follow-up treatments are not installed, the actual returns realized will be lower than the estimates (table 14).

Intermediate treatments in northern hardwoods had a high average IROR (15.0%), higher than for southern pine treatments. The major reason is change in species composition brought about by the practice, coupled with high stumpage prices. Eighty percent of the cases can earn the 6-3/8% return.

Intermediate treatments in cove hardwoods had an even higher average IROR (16.0%) and so did black walnut intermediate treatments (16.9%). Both of these "fine hardwood" treatments had below-average percentages of cases earning 6-3/8%, though, just over 70% for both practices.

Intermediate treatments in Douglas-fir had a higher average IROR (14.8%) than similar treatments of eastern conifers. Less than half of the Douglas-fir intermediate treatment practices could earn 6-3/8%, however.

The primary reason that individual cases in the high performance program segments could not earn the 6-3/8% return limit was failure to pass one of the silvicultural thresholds, such as minimum plantation stocking (append. table A14). Cases that did pass the silvicultural thresholds, however, could usually earn 6-3/8%. The only two exceptions were intermediate treatments in black walnut and Douglas-fir. In these practices, some cases that passed the silvicultural thresholds failed to earn 6-3/8%. This usually resulted from some combination of low sites and/or high treatment costs. The high cost and low sites of some Pacific Coast investments in 1974 was noted in the first stage evaluation of the 1974 FIP evaluation (Mills 1976).

The low performance program segments were predominantly conifer treatments. Timber stand improvements in slash pine and oak-pine stands were low performance segments (table 15). With a low average IROR, only 12% and 19%, respectively, could earn 6-3/8%.

Treatment of slash pine and oak pine stands above the maximum stand age threshold were the primary reason for the low performance. This finding is contrary to the high returns for southern pine and oak-pine timber stand improvement derived by Anderson (1968). The reason is that some individual trees removed during the practice were sold in Anderson's analysis, which lowered the effective practice cost. No such salvage was assumed in this study. Extensive salvage is not permitted in FIP practices and the ground measurements indicate that little salvage occurred in this practice.

Shortleaf pine plantings had an average IROR of 5.7% with 25% earning 6-3/8%. Most loss is due to low financial returns rather than inadequate stocking. Shortleaf pine rotations are longer than the loblolly and slash pine rotations. Shortleaf pine is also planted in lower stumpage price regions.

White pine plantings had an IROR of 6.1% and 50% can earn 6-3/8%, even though there is a large MAI increase. The reason white pine plantings fail to earn 6-3/8% is split between inadequate stocking and low financial returns even when stocking is above the 200 seedling limit.

Spruce plantings have a lower than average IROR and percentage of cases earning 6-3/8%. Timber stand improvements in spruce-fir and hemlock have an average IROR of 3.0%.

Ponderosa pine plantings and timber stand improvements were both low performance segments

Table 14. Major segments of the 1974 FIP program which exhibited relatively high financial return and timber yield performance

Program segment[1]	Weighted average IROR	Percent of cases earning 6-3/8%	Weighted average MAI increase
	(percent)		*(cu. ft./ac./yr.)*
1. Loblolly pine, planting	10.9	93	110.1
2. Slash pine, planting	12.4	90	104.8
3. Loblolly pine, understory release	12.6	97	91.3
4. Northern hardwood, timber stand improvement	15.0	80	10.4
5. Cove hardwood, timber stand improvement	16.0	72	26.9
6. Black walnut, timber stand improvement	16.9	71	4.1
7. Douglas-fir, timber stand improvement	14.8	48	39.9

[1]*In some situations these "segments" are aggregations of the detailed groups shown in appendix table A. "Timber stand improvement" includes the precommercial thinning, intermediate treatments, prune and intermediate treatment, and prune practices, for example.*

Table 15. Major segments of the 1974 FIP program which exhibited relatively low financial return and timber yield performance

Program segment[1]	Weighted average IROR	Percent of cases earning 6-3/8%	Weighted average MAI increase
	(percent)		*(cu. ft./ac./yr.)*
1. Slash pine, timber stand improvement	3.2	12	4.5
2. Oak-pine, timber stand improvement	4.8	19	3.2
3. Shortleaf pine, planting	5.7	24	62.6
4. White pine, planting	6.1	49	126.9
5. Spruce, planting	6.7	63	106.2
6. Spruce-fir & hemlock, timber stand improvement	3.0	24	1.5
7. Oak-hickory, timber stand improvement	4.7	43	9.5
8. Ponderosa pine, planting	2.0	11	12.4
9. Ponderosa pine, timber stand improvement	3.7	26	1.6

[1]*In some situations these "segments" are aggregations of the detailed groups shown in appendix table A. "Timber stand improvement" includes the precommercial thinning, intermediate treatments, prune and intermediate treatment, and prune practices, for example.*

with an IROR of 2.0% and 3.7% respectively. The MAI increases and percentages that can earn 6-3/8% return are also quite low.

The only major hardwood treatment that ranked low by these indicators was timber stand improvement in oak-hickory stands. The MAI increase was low (9.5 cubic feet), as it was for most hardwood treatments but the average IROR was also low (4.7%). Only 43% of the cases can earn 6-3/8%. The low percentage resulted from cases exceeding the silvicultural thresholds, particularly the one for maximum stand age. Unfortunately, these oak-hickory treatments constitute a major share of the FIP program in several central-region states.

In summary, the average estimated financial return and timber yield increase of the 1974 FIP investments are quite high. There are several major program segments which rate low against the financial return and yield criteria, however. The occurrence of low performance segments is analyzed in the following section and recommendations are made for possible program redirection.

Practices Which Require Timely Follow-up Treatment

The ground measurements from the 1974 sample cases indicate that some of the initial FIP treatments need to be followed by subsequent treatments, specifically: removal of residual basal area, hardwood or brush control in plantations, or precommercial thinning due to overstocked seedlings. Most of the needed follow-up treatments occur in conifer planting cases. In the financial return and yield increase analysis, all subsequent treatments are assumed to take place. A yield penalty was registered for these cases, however, affecting financial return. If the follow-up treatments are not done, actual returns and yield increases will be much lower than the estimated returns.

If plantations exceeded 10 square feet of residual overtopping basal area at the time of the ground measurement 1 to 1½ years following initial treatment, a follow-up treatment to remove the basal area was included. In southern pine plantings, 4.2% or an estimated 239 cases had more than 10 square feet of residual basal area (table 16). The average residual basal area for those cases was 30 square feet. The residual trees were 7 to 12 inch pine trees scattered across all of the measurement points on the sample tracts.

One explanation for this situation is that stumpage markets were soft in 1974 and the residual volume was not merchantable at that time. Another explanation is that the 5-year prior harvest rule was in effect in 1974. These may be very good planting opportunities but the overtopping trees must be removed before seedling survival is significantly affected. Some seedling survival and yield penalty were assessed against these cases. A much safer strategy in the future would be to wait until the overstory is removed before the trees are planted. That way the success of an initially costly practice, is not contingent upon a subsequent and uncertain management decision or variations in stumpage markets.

Residual basal area is much more prevalent in southern pine understory release cases than in the planting cases. Over half or 311 of these cases had excessive residual basal area per acre. The average was 43 square feet for cases that exceed the 10 square feet basal area threshold test. As in the planting cases, the

trees were mostly 5 to 12 inch crop trees, some hardwood mixed with the pine, and were usually spread across the entire tract.

A less risky future strategy here too would be to remove all of the overtopping basal area at the time of the first treatment. If insufficient numbers of established seedlings exist, postpone the treatment until enough are present or harvest the stand and plant. The planting and release cases that had overtopping basal area occurred almost exclusively in the south-central states of Oklahoma, Texas, and Louisiana.

Roughly 6.7% or 615 of the eastern conifer planting cases had enough hardwood volunteers in relation to the surviving planted seedlings to signal the need for a follow-up hardwood control treatment. Unlike the residual basal area situation, hardwood volunteers cannot be avoided by changing the nature of the initial practice. Hardwood control is simply a necessary part of the job of growing pines on some sites.

Seedling overstocking occurred in 20.5% or 114 of the southern pine understory release cases. This is also difficult to avoid at the time of initial treatment. A large percentage of the Douglas-fir planting cases also require brush control (79.0%). In total, an estimated 1,390 or 8.7% of the 1974 FIP cases require some immediate follow-up treatment.

Identification of needed follow-up is particularly important for non-industrial private owners that participated in FIP. A large percentage of these owners would not have applied the initial practice without the technical and/or the financial assistance provided by FIP and probably will not apply needed follow-up practices unassisted. Previous studies by Kurtz et al. (1978), Shackelford (1976), and Kingsley and Mayer (1972) support the hypothesis that follow-up treatments are not applied on nonindustrial private lands as frequently as needed.

Follow-up assistance, at least of a technical nature, should be an integral part of the program delivery structure. This may only be accomplished under existing money and manpower constraints at the expense of signing new cases. The follow-up treatments are usually low cost practices, but they "protect" much more costly planting practices. New and costly planting treatments are questionable if the potential of past plantings is not achieved for want of a low cost and financially justifiable follow-up treatment. This is just one more facet on the question of program quality versus quantity. Too much emphasis on program size often results in lower quality and smaller final program effect in turn.

Practices that Failed to Pass Silvicultural Threshold Tests

Four silvicultural threshold categories were used to identify cases likely to produce negligible yield increase: insufficient plantation stocking, treatment of old stands, treatment of understocked stands, and removal of insufficient basal area (table 3). Some cases, particularly plantations, failed threshold tests because of natural factors that were not predictable at the time the practice was installed. These are simply the risks of growing a timber crop. There were cases though, where the prescribing forester could have developed information to indicate that the case probably would fail. These situations are labeled "management controllable" threshold failures.

Eleven percent or 1,165 of all the 1974 plantation cases had insufficient surviving seedling stocking to justify carrying the plantation to maturity. Ground observer comments were studied to determine if the low stocking could have been avoided by proper pre-

Table 16. Specific follow-up treatments needed and scope of each

Follow-up treatment and practice category	Percent of practice category affected	Number of cases	Predominant states
Remove overtopping basal area from southern pine plantings	4.2	239	Louisiana Oklahoma Texas
Remove overtopping basal area from released seedlings, southern pine	56.1	311	Louisiana Mississippi Oklahoma Texas
Hardwood control in southern pine and northern conifer plantings	6.7	615	North Carolina South Carolina Pennsylvania
Precommercial thinning in overstocked southern pine release cases	20.5	114	Texas Mississippi Virginia
Spray for brush control in Douglas-fir plantings	79.0	111	Oregon Washington
Total	8.7	1390	

Table 17. Management controllable situations when silvicultural thresholds were exceeded

Threshold affected	Percent of class affected	Number of cases	Major practice categories
Insufficient plantation stocking	6.4	649	Southern pines Northern conifers Western conifers
Treatment of old stands	21.3	1087	Oak-hickory Southern pines
Removal of insufficient basal area	4.9	235	Oak-hickory
Treatment of understocked stands	2.4	113	
Total	13.1	2084	

scription and treatment. Over half of the plantation failures were management controllable (table 17). The reasons given include inadequate site preparation, poor planting stock, and failure to remove overtopping trees. About half of the southern pine and northern conifer plantation failures were identified as management controllable (table 18). Since this designation was made using remarks from ground observers, it may understate the problem. All of the Douglas-fir and ponderosa pine plantation failures measured at the age of 1 to 1½ years were identified as management controllable.

A closer look at the distribution of plantations by stocking class in figure 5 shows that a large percentage of the slash pine and loblolly pine plantations fell in the "optimum" stocking range of 400 to 599 surviving seedlings per acre. Roughly 20% fell in the 200 to 399 tree range. Even though these latter cases exceed the 200 tree minimum stocking threshold, a yield penalty was assessed, usually by foregoing early thinnings until stand density reached full stocking. The distribution of northern conifer plantations in figure 6 shows a similar relationship although the largest concentration of red pine and spruce-fir plantations are in a higher stocking class—600 to 799 surviving seedlings.

Study of recorded ground measurement indicated that almost all of the timber stand improvement cases which exceeded silvicultural thresholds fell into the management controllable category. Treatment of over-aged stands was the most common threshold exceeded. This occurred in 1,087 cases or 21.3% of the timber stand improvement cases.

Treatment of old stands was especially prevalent in oak-hickory and southern pine and oak-pine timber stand improvements. Half of the oak-hickory timber stand improvements were over the 45-year silvicultural threshold (table 18).

Figure 7 also shows that most cases did not fall just over the threshold. Ten percent of the oak-hickory cases were stands over 80 years old. A small number of the cases over 45 years old may have an acceptable IROR if the species composition is improved significantly by the practice. Some yield increase can also be achieved by treatment of some of these stands, but they are decidedly low priority treatments.

The largest share of the southern pine cases over the age threshold were slash pine cases which were compared against a 20-year threshold (fig. 8). Fourteen percent of the northern hardwood timber stand improvements were over the 60 year threshold and about half as many black walnut and cove hardwood cases were. The black walnut and cove hardwood cases were largely 20 to 45 years old, which is very desirable for timber yield effect.

All of the red pine stands were between 11 to 30 years old at the time of treatment (fig. 9). Treatment of 40 to 50 year old white pine and spruce-fir stands was not uncommon though. Only 10% of the ponderosa pine stands were less than 40 years old at the time of treatment (fig. 10). Forty-five percent were over 70 years old, some going as high as 89 years. Older maximum age thresholds were used on western types than on eastern conifer types.

Removal of insufficient basal area occurred in 235 cases which was less frequent than the excessive age problem. This "light treatment" situation occurred in more than 5% of the timber stand improvements in southern pine and oak-pine, northern conifers, and oak-hickory stands (table 15). Treatment of understocked stands that were understocked before the practice was applied occurred in 113 cases.

In total, 2,084 cases exceeded the silvicultural thresholds used in this study. The thresholds were based upon standard silvicultural information, such as stand age, stocking, and species composition. If this stand information had been collected and properly evaluated, many cases would have been treated differently or would have been rejected for treatment. Over half (51%) of the oak-hickory timber stand improvements and 44% of the southern pine and oak-pine timber stand improvements failed the basic silvicultural threshold tests used in this study.

Conclusions and Recommendations

The average financial returns for the 1974 Forestry Incentives Program (FIP) are quite high. The average real internal rate of return (IROR) was 10.2%. The average and total yield increase resulting from the 1974 cases is also quite high. This is impressive con-

Table 18. Reasons that silvicultural thresholds were exceeded, by species group

Practice and reason	Southern pine and oak-pine	Northern conifers	Oak-hickory	Northern hardwood	Black walnut and cove hardwood	Douglas-fir	Ponderosa pine
				(percent of cases)			
Plantations:							
Management causes[1]	3.2	7.7	—	—	—	21.5	82.1
Natural[2]	1.6	0.9	—	—	—	—	—
Other[3]	0.7	2.4	—	—	—	—	—
No reason	1.8	4.4	—	—	—	—	—
Total	7.2	15.3	—	—	—	21.5	82.1
Intermediate:							
Excessive stand age	30.2	3.3	50.2	14.2	7.7	16.2	36.7
Treatment of understocked stands	4.7	2.4	1.2	1.0	2.8	5.9	—
Removal of insufficient basal area	8.9	6.6	5.2	1.5	4.5	—	—
Other[4]	—	0.8	—	2.4	—	4.1	7.0
Total	43.8	13.1	56.9	19.2	15.0	26.1	43.7

[1]*Management causes include: poor planting stock, inadequate site preparation, incorrect species, grazing of site, planting under an overstory.*
[2]*Natural causes include: fire, drought, flooding.*
[3]*Other includes: land use change, ownership changes*
[4]*Other includes: land use change, removal of understory hardwoods.*

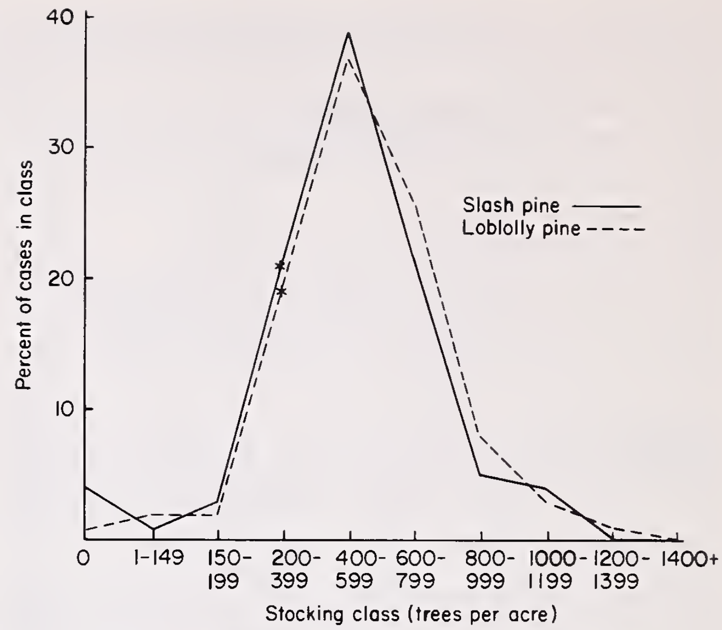

Figure 5.—Distribution of loblolly pine and slash pine plantation by stocking class.

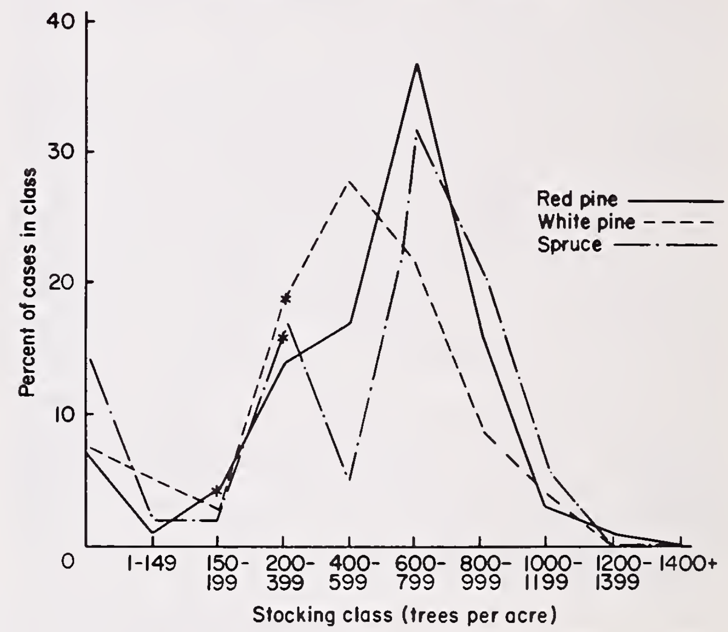

Figure 6.—Distribution of red pine, white pine, and spruce-fir plantation by stocking class.

sidering that it was the first program year and the greatest administrative effort was aimed at development of an operational program rather than upon program composition.

Several major program segments had even higher average financial returns and/or yield increase. The loblolly and slash pine plantings and timber stand improvements in northern hardwoods, cove hardwoods, and black walnut stands are particularly noteworthy.

Some segments of the 1974 program had estimated financial returns below the 6-3/8% target rate and yield increase estimates far below the average for the

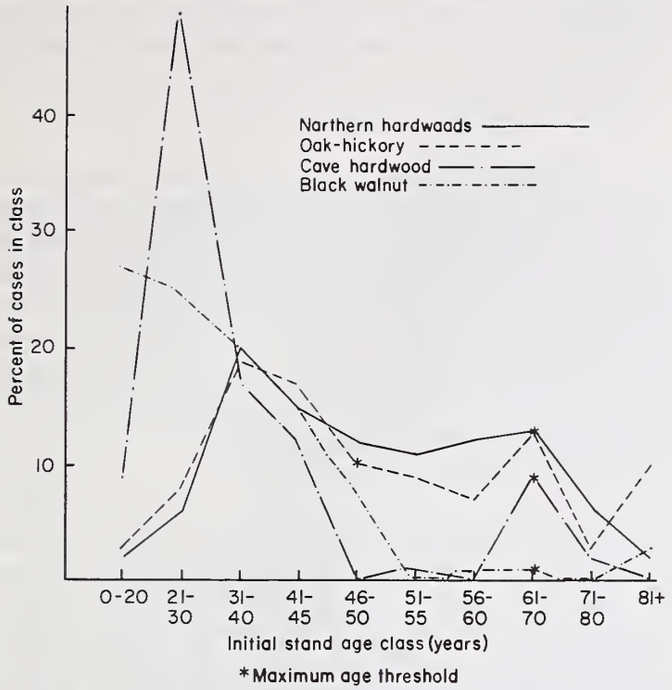

Figure 7.—Distribution of hardwood timber stand improvement cases by initial stand age classes.

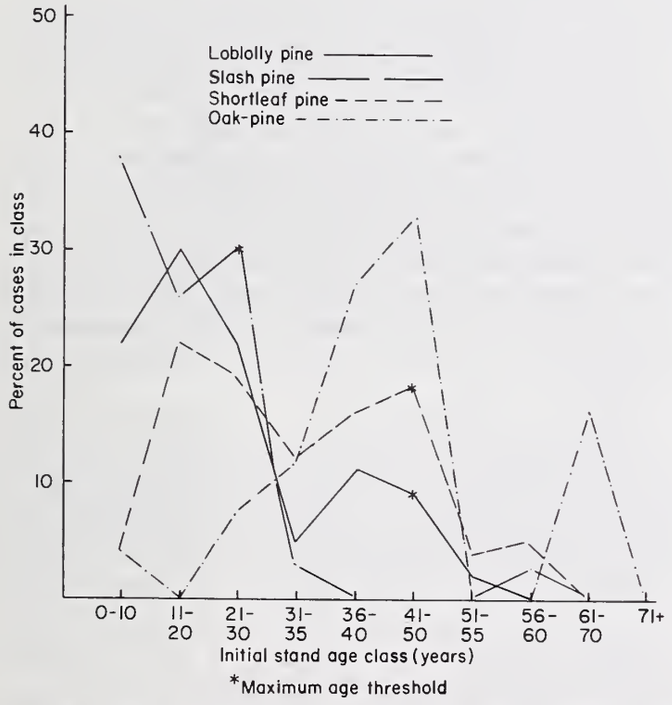

Figure 8.—Distribution of southern pine timber stand improvement cases by initial stand age classes.

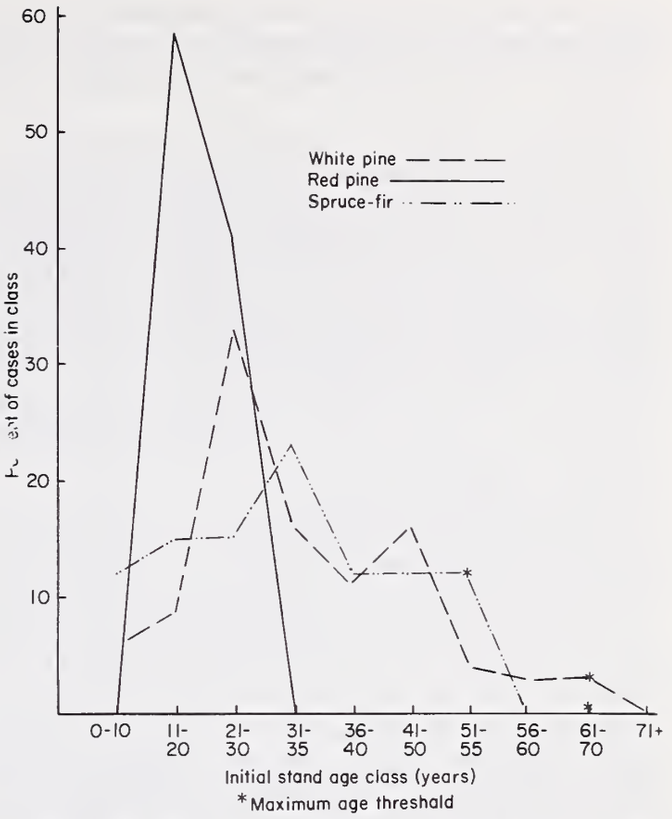

Figure 9.—Distribution of northern conifer timber stand improvement cases by initial stand age classes.

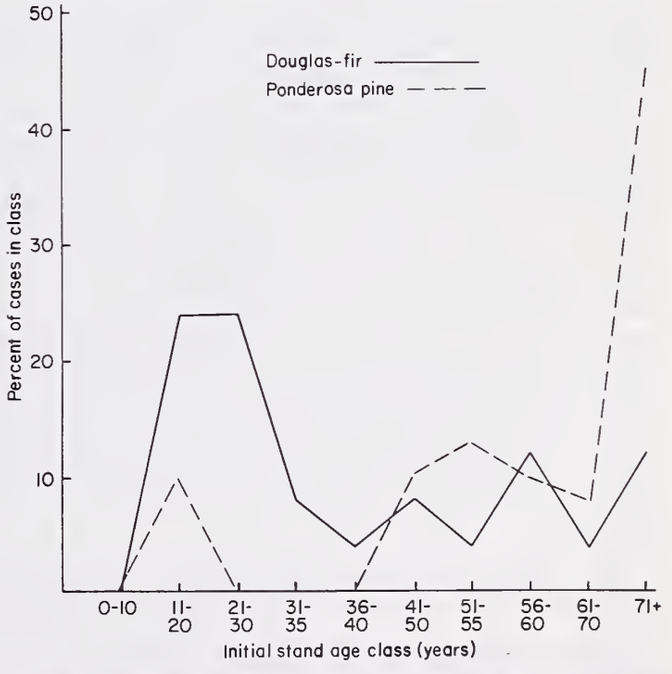

Figure 10.—Distribution of western conifer timber stand improvement cases by initial stand age classes.

1974 investments. A small percentage of these were the result of natural risks, such as drought. Most were the result of management decisions made at the time the practice was prescribed or at the time the treatment was installed.

Five recommendations for program modifications may help improve the performance of FIP in future years. While some aspects of certain recommendations are already included in program regulation changes since 1974, a more consistent and structured approach may be needed in some areas.

Recommendation #1: Develop detailed silvicultural guidelines to identify case and treatment conditions that are likely to produce only a negligible yield increase.

In 1974, an estimated $1.3 million dollars of federal and private cost-shares was spent on cases that exceeded the silvicultural thresholds, $0.9 million of that was federal funds. Additional program delivery funds were also spent. If the silvicultural guidelines embodied in this study's thresholds had been used in 1974, the average IROR would have been 12.1% rather than 10.2%. The average MAI increase would have been 87 cubic feet per acre versus 74 cubic feet and 87% of the cases would have earned 6-3/8% rather than 75% of the cases.

Guidelines may also be developed to identify the top priority investments in addition to developing guidelines that exclude only the low priority ones. Overall performance may be improved most rapidly by excluding the low performance segments first, however.

The silvicultural threshold approach used in this study simply employs some basic timber-growing knowledge that has been available and accepted for some time. The maximum stand age threshold for timber stand improvements in oak-hickory is a good example. A silvicultural guide for oak-hickory recommending a 45-year maximum stand age was published in 1971 (Gingrich) yet almost half of the oak-hickory timber stand improvement cases were over 45 years old and 10% were over 80 years old.

Some information needed for silvicultural guidelines is available in published form. Many more guidelines are required, however, which can only be based on more fragmentary research and professional judgment. Even if published guides were available for all types, it is questionable that simply referring service foresters to a scattering of published sources will lead to their use. The service forester should be given the silvicultural guidelines in one source document. The guidelines should be developed in a relatively consistent format by professionals familiar with the practices and forest types involved.

The first priority for implementation of silvicultural guidelines is timber stand improvements in oak-hickory, southern pines, and oak-pines. Second priority is timber stand improvements in the other softwood species. Third priority is timber stand improvements in other hardwoods and site preparation guidelines for pine plantings.

There is already evidence that steps have been taken by some states down this path. The practice guidelines for hardwood timber stand improvement developed in Tennessee are a good example. A more concerted and consistent nationwide effort is needed, however.

Recommendation #2: Develop maximum cost guidelines for the federal cost-share by practice, species, site index, and region so that all assisted cases can earn at least some minimum financial return.

For example, a site preparation and planting cost of $150 an acre may just yield a 6-3/8% return for a loblolly pine plantation on site 80 land in price region 10. If a 75% cost-share rate is used, the maximum federal cost-share for the practice would be $113. If a particular tract costs more than that to treat, the owner would have the option of paying the added cost, thereby lowering the federal cost percentage. The federal share would remain $113.

The maximum cost guidelines could be developed at a number of levels of geographic aggregation. There are advantages to each level. If a relatively disaggregated approach such as state-by-state, is used, care must be taken to insure that the analytical procedures used are consistent. Financial return is much more sensitive to the initial treatment cost than any of the subsequent costs or returns (Mills et al. 1976) and different analysis formats can give widely different answers.

If the silvicultural thresholds and maximum treatment cost guidelines, set to achieve a minimum 6-3/8% return target, had both been in use in 1974, the average real IROR of all cases would have been 12.5% and 96% of the cases would have earned 6-3/8%. The remaining 4% of the cases were unpredictable plantation failures. In 1974, an estimated $0.8 million dollars in federal plus private cost-shares, $0.6 million of which was federal cost-shares, was spent on cases that passed the silvicultural thresholds but failed to earn 6-3/8% because of a combination of species, site index, and price region effects.

Priority should be given to maximum treatment cost guidelines for shortleaf pine, red and white pine, ponderosa pine, and Douglas-fir plantings. All of these had a significant percentage of cases that passed the silvicultural thresholds but could not earn 6-3/8%. Attention has been given to treatment costs ever since the first program year and since the first stage evaluation was complete. A more structured and complete approach is warranted.

Recommendation #3: Distribute cost-shares among assistance cases in a manner more sensitive to the actual cost of treating each case, constrained by the maximum cost-share guidelines.

Because little site preparation is needed, a particular site 80 loblolly pine plantation in price region 10 may only cost $90 per acre. The prescribing forester

should estimate this cost and recommend that the landowner be given $68 per acre in federal cost-shares, if the 75% share level is used. That tract should not be given $113, just because that is the maximum cost-share permitted for that practice.

Recall that the first stage evaluation concluded that there was unexplained cost variation among the states. The attempt to relate FIP treatment costs to major cost determinants such as terrain factors and the amount of basal area removed also failed. These results, and personal communication with federal and state personnel, indicate that maximum treatment cost ceilings were used in many instances in lieu of a cost-share allocation procedure which was more sensitive to the actual treatment cost of individual cases.

The probable result was that many cases received a higher cost-share than was necessary to achieve the 75% cost-share ceiling set by law. It also reduces the financial return on the investments and raises an equity question of why cost-share percentages should vary among participants. Establishment of cost-share maximums by practice, species, site index, and region as called for in Recommendation #2 should help solve this problem. Development of actual treatment cost prediction equations that could be applied case-by-case would be even more efficient, though.

The new 1978 program year regulation that permits the prescribing forester to estimate treatment cost is a step in the right direction. Some states also have varying cost maximums that relate the federal cost-share to the amount of basal area removed by the treatment. Again, a more concerted effort would improve investment efficiency.

Recommendation #4: Avoid installing practices that require immediate follow-up treatments if the practice can be installed in an alternative manner where success is not so sensitive to successful follow-up.

This recommendation is not intended to exclude efficient practices which require rapid follow-up. For example, direct seeding followed by a precommercial thinning may be more financially desirable than planting. Hardwood control may also be an integral part of plantation growth in the South on some sites. This recommendation is directed at the residual basal area cases found in the southern pine planting and southern pine understory release practices. These practices appear to needlessly place the initial investment in jeopardy. The same recommendation applies to similar practices that lead to similar conditions.

Recommendation #5: Insure that follow-up visitations to the site of the initial practice are an integral part of the program delivery structure.

Past studies of assistance programs indicate that follow-up treatment was not applied as frequently as needed. This study identifies several areas where follow-up treatments should be applied. The need for hardwood control in pine plantations is frequent enough in the 1974 cases to warrant special attention, as is the need for brush control in Douglas-fir plantations. Southern pine understory release cases were also frequently overstocked enough to need a precommercial thinning.

Similarly, commercial thinnings occur in many of the intermediate treatments in hardwoods within 10-20 years after initial treatment. Although it is not as time sensitive as subsequent treatments, the presence of the commercial thinning does influence the financial return on investment.

Whether identification of the needed follow-up leads to a subsequent technical and/or cost-sharing assist is a question of program policy. Attention to new case sign-ups at the expense of adequate follow-up practices, however, will have a significant effect upon the financial return to timber output and the timber yield increase.

Most of these recommendations, are guidelines or standards that the service forester can apply on the ground during the case selection and prescription process. The guidelines would inevitably let a few low priority investments through and block some high priority investments from assistance. If properly designed, however, the guidelines would significantly reduce the amount of low priority cases in the program very quickly.

The guidelines could be developed at one or a few central locations by individuals familiar with the analytical techniques involved. The service forester will still have to use a great deal of professional judgment in the application of the guidelines to individual situations. Freed of the detailed analysis, the forester could spend the majority of this time in locating new assists, checking for follow-up practices, making treatment prescriptions, and checking for practice completion; tasks for which the forester is uniquely situated and trained.

It has been suggested that the forester actually do the financial analysis for each case before approving assistance. While this exercise would force the forester to place all the physical and economic information at hand into a helpful format, it would detract from the tasks that only he can do. In many cases it would also result in inconsistent and incomplete analysis.

The guideline approach, where the guidelines are developed in a consistent manner, is a more practical

approach that will yield the greatest and quickest improvement. Implementation of the five recommendations drawn from this study, while at the same time maintaining recent gains such as the 10-acre minimum tract size standard, will increase the timber performance of FIP significantly.

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Appendix

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Growth and Yield

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Appendix Table A1. Sample ground measurement reporting form for a site preparation and planting case.

Forestry Incentives Program
Treatment Analysis Record

Card 1 (80)

(1) A. Location Description (31)

1. Sample Number	14820	7. Site Index	070
2. State	13	8. Site Species	131
3. County	251	9. Slope	1
4. Farm Number		10. Physiographic Class	3
5. Prior CFM	1	11. Adjacent Available Acres	128
6. Prior Land Use	1	12. Treatment Applied	1

Card 2 (80)

B. Stand Conditions

(6) Pretreatment Conditions		Post Treatment Conditions (77)	
13. Crop Species	131	13. Crop Species	
14. Crop BA/AC	040	14. Crop BA/AC	
a. Additional Crop BA/AC		a. Additional Crop BA/AC	
15. Other Trees BA/AC	120	15. Other Trees BA/AC	

Card 3 (80)

(6)		(29)	
16. Dominant/Codom. Average DBH	06	16. Dominant/Codom. Average DBH	
17. Dominant/Codom. Average Height	025	17. Dominant/Codom. Average Height	
18. Dominant/Codom. Average Age	030	18. Dominant/Codom. Average Age	
19. Operability	2	19. Operability	2
20. Acres To Be Treated	052	20. Acres Treated	052

C. Tree Planting

(30) Prescribed		(53) Observed	
21. Planting Treatment	2	21. Planting Treatment	2
a. Method of Site Preparation	1	a. Method of Site Preparation	1
b. Intensity of Site Preparation	3	b. Intensity of Site Preparation	3
22. Species	131	22. Species	131 / 800 / 400 / Other

Card 4 (80)

(6)		(65) No/Acre			
a. No./ Acre	05445	a. Planted	03811	01010	01900 / 00000
		b. Volunteer	00100	12124	01057 / 00811
		c. F.T.G.	03811	01891	01049 / 01057

D. Timber Stand Improvement Treatment

Card 5 (80)

(6) Prescribed		Observed (43)	
23. Precommercial Thinning Method		23. Precommercial Thinning Method	
24. Pruning Method		24. Pruning Method	
a. Number Trees/Acre Pruned		a. Number Trees/Acre Pruned	
b. Average Pruned Height		b. Average Pruned Height	
25. Crop Tree Release Method		25. Crop Tree Release Method	
a. Number Crop Trees/Acre To Be Released		a. Number Crop Trees/Acre Released	
		b. Average Distance Between Crowns	
26. Understory Release Method		26. Understory Release Method	
a. No. Established Seedlings/Acre		a. No. Established Seedlings/Acre Released	
27. Cull Removal Method		27. Cull Removal Method	
28. Site Prep.--Natural Regeneration Method		28. Site Prep.--Natural Regeneration Method	

E. Professional Observations

(44)	(50)
29. Were Treatments Prescribed Correct?	
30. Were Treatments Applied As Prescribed?	
31. What is Next Likely Treatment?	
32. When? 15 Years	33. Number of Observations 37

34. F -- Remarks Prescribed burning used in site prep. Bulldozing apparently done in strips with hand injection work done on residual cull trees. Despite large number of oak sprouts, I believe the pine seedlings will overtop them in 4 to 7 years.

35. _____ Observer

36. _____ Date

Appendix Table A2. Sample ground measurement reporting form for a timber stand improvement case.

Forestry Incentives Program
Treatment Analysis Record

Card 1 (80)

(1) A. Location Description (31)

1. Sample Number	5 8 5 1 1	7. Site Index	0 7 0
2. State	3 3	8. Site Species	3 1 7
3. County	0 0 9	9. Slope	1
4. Farm Number		10. Physiographic Class	6
5. Prior CFM	1	11. Adjacent Available Acres	0 8 5
6. Prior Land Use	1	12. Treatment Applied	2

Card 2 (80)

B. Stand Conditions

(6) Pretreatment Conditions		(77) Post Treatment Conditions	
13. Crop Species	3 1 7 3 1 8 5 4 1 3 7 1	13. Crop Species	3 1 7 3 1 8 5 4 1 3 7 1
14. Crop BA/AC	0 1 6 0 1 4 0 0 8 0 0 4	14. Crop BA/AC	0 1 6 0 1 4 0 0 8 0 0 4
a. Additional Crop BA/AC		a. Additional Crop BA/AC	
15. Other Trees BA/AC	0 7 8	15. Other Trees BA/AC	0 4 4

Card 3 (80)

(6)		(29)	
16. Dominant/Codom. Average DBH	0 9	16. Dominant/Codom. Average DBH	0 9
17. Dominant/Codom. Average Height	0 6 5	17. Dominant/Codom. Average Height	0 6 5
18. Dominant/Codom. Average Age	0 5 0	18. Dominant/Codom. Average Age	0 5 0
19. Operability	2	19. Operability	2
20. Acres To Be Treated	0 0 4	20. Acres Treated	0 0 4

C. Tree Planting

(30) Prescribed		(53) Observed	
21. Planting Treatment		21. Planting Treatment	
a. Method of Site Preparation		a. Method of Site Preparation	
b. Intensity of Site Preparation		b. Intensity of Site Preparation	
22. Species		22. Species	Other

Card 4 (80)

(6)		(65) No/Acre	
a. No./ Acre		a. Planted	
		b. Volunteer	
		c. F.T.G.	

D. Timber Stand Improvement Treatment

Card 5 (80)

(6) Prescribed		(43) Observed	
23. Precommercial Thinning Method	1	23. Precommercial Thinning Method	1
24. Pruning Method		24. Pruning Method	
a. Number Trees/Acre Pruned		a. Number Trees/Acre Pruned	
b. Average Pruned Height		b. Average Pruned Height	
25. Crop Tree Release Method	5	25. Crop Tree Release Method	5
a. Number Crop Trees/Acre To Be Released	1 0 0	a. Number Crop Trees/Acre Released	0 9 5
		b. Average Distance Between Crowns	2 0
26. Understory Release Method		26. Understory Release Method	
a. No. Established Seedlings/Acre		a. No. Established Seedlings/Acre Released	
27. Cull Removal Method		27. Cull Removal Method	
28. Site Prep.--Natural Regeneration Method		28. Site Prep.--Natural Regeneration Method	

E. Professional Observations

(44)	(50)
29. Were Treatments Prescribed Correct?	1
30. Were Treatments Applied As Prescribed?	1
31. What is Next Likely Treatment?	1
32. When? 1 0 Years	33. Number of Observations 0 5

34. F -- Remarks: An excellent job of thinning in northern hardwoods. Adjacent commercial operation salvaged much of the small amount of merchantable timber killed to properly effect the release. Trees were killed with a frill and silvisar. Results of this were excellent on all observed species.

35. _____ Observer

36. _____ Date

Appendix Table A3. Definitions of the species group codes used to distinguish between stylized management regimes

Species group code	Definition
1. Slash pine:	the greatest number of the surviving planted seedlings are slash pine; or in the case of a timber stand improvement where greater than 50% of the crop basal area is longleaf, loblolly, shortleaf, and/or slash pine, slash pine has the greatest amount of basal area.
2. Longleaf pine:	the greatest number of the surviving planted seedlings are longleaf pine; or in the case of a timber stand improvement where greater than 50% of the crop basal area is longleaf, loblolly, shortleaf and/or slash pine, longleaf pine has the greatest amount of basal area.
3. Loblolly pine:	the greatest number of the surviving planted seedlings are loblolly pine; or in the case of a timber stand improvement where greater than 50% of the crop basal area is longleaf, loblolly, shortleaf and/or slash pine, loblolly pine has the greatest amount of basal area.
4. Shortleaf pine:	the greatest number of the surviving planted seedlings are shortleaf pine; or in the case of a timber stand improvement where greater than 50% of the crop basal area is longleaf, loblolly, shortleaf and/or slash pine, shortleaf pine has the greatest amount of basal area.
5. Virginia pine and other southern pine:	the greatest number of the surviving planted seedlings are Virginia pine or other southern pine; or in the case of a timber stand improvement where greater than 50% of the crop basal area is Virginia pine and/or other southern pine.
6. Oak-pine:	greater than 50% of the crop basal area is northern red oak, southern red oak, white oak, other oaks, hickory, gums, and/or sweetgum, and 15% to 50% of the crop basal area is longleaf, loblolly, shortleaf and/or slash pine.
7. Red pine:	the greatest amount of the surviving planted seedlings are red pine; or in the case of pruning the greatest amount of the crop basal area is red pine.
8. White pine:	the greatest amount of the surviving planted seedlings are white pine; or in the case of pruning the greatest amount of the crop basal area is white pine.
9. Spruce/Spruce-fir:	the greatest amount of surviving planted seedlings are black spruce, red spruce, white spruce, balsam fir, and/or other true firs; or in the case of a timber stand improvement, greater than 50% of the crop basal area is black spruce, red spruce, white spruce, balsam fir, and/or other true firs.
10. Northern pine:	greater than 45% of the crop basal is eastern white pine, red pine, jack pine, and/or hemlock, but less than 47% of the crop basal area is hemlock, and/or less than 45% is hard maple, soft maple, beech, yellow birch, black cherry, and/or basswood.
11. Jack pine:	the greatest amount of the surviving planted seedlings are jack pine.
12. Oak-hickory:	greater than 49% of the crop basal area is hickory, northern red oak, southern red oak, white oak, other oaks, yellow poplar, elm, and/or white ash but less than 8% of the crop basal area is black walnut, less than 15% of the crop basal area is loblolly, longleaf, slash, shortleaf, less than 60% is yellow poplar, and/or less than 41% is white ash.
13. Cove hardwood:	greater than 60% of the crop basal area is yellow poplar or greater than 41% of the crop basal area is white ash, but less than 8% of the crop basal area is black walnut.
14. Black walnut:	black walnut seedlings have been planted or in the case of a timber stand improvement greater than 7% of the crop basal area is black walnut.
15. Northern hardwood:	greater than 45% of the crop basal area is hard maple, soft maple, beech, yellow birch, black cherry, basswood and/or white ash, but less than 8% of the crop basal area is black walnut, and/or less than 41% of the crop basal area is white ash.
16. Hemlock:	greater than 47% of the crop basal area is hemlock, but less than 45% is hard maple, soft maple, beech, yellow birch, black cherry and/or basswood.
17. White birch:	greater than 40% of the crop basal area is white birch and/or yellow birch, but less than 45% is hard maple, soft maple, beech, yellow birch, black cherry, and/or basswood, and/or less than 45% of the crop basal area is eastern white pine, red pine, jack pine, and/or hemlock.
18. Larch:	greater than 90% of the surviving planted seedlings are larch.
19. Ponderosa pine:	ponderosa pine was the planted species, or the crop trees were predominantly ponderosa pine.
20. Douglas-fir:	Douglas-fir was the planted species, or the crop trees were predominantly Douglas-fir.
21. Lodgepole pine:	the crop trees were predominantly lodgepole pine.

Appendix Table A4. Stylized yields in cubic feet/acre/year by initial practice, species group and three site index ranges

Practice	Species	Site index range	Number of thins[1]	Rotation age	Intense			Current			Net Change		
					Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total
Plant[2]	Slash pine	[3]66-75	2	30	15.27	61.67	76.93	0.00	[4]0.00	0.00	15.27	61.67	76.93
		76-85	2	30	22.60	91.27	113.86	0.00	[4]0.00	0.00	22.60	91.27	113.86
		86-95	2	30	30.99	125.18	156.17	0.00	[4]0.00	0.00	30.99	125.18	156.17
Plant[5]	Longleaf pine	66-75	3	55	24.55	38.02	62.57	0.00	[4]0.00	0.00	24.55	38.02	62.57
		[3]76-85	3	55	32.73	50.69	83.42	0.00	[4]0.00	0.00	32.73	50.69	83.42
		86-95	3	55	39.27	60.83	100.10	0.00	[4]0.00	0.00	39.27	60.83	100.10
Plant[6]	Longleaf pine	66-75	3	50	36.00	55.80	91.80	0.00	[4]0.00	0.00	36.00	55.80	91.80
		[3]76-85	3	50	48.00	74.40	122.40	0.00	[4]0.00	0.00	48.00	74.40	122.40
		86-95	3	50	57.60	89.28	146.88	0.00	[4]0.00	0.00	57.60	89.28	146.88
Plant[7]	Loblolly pine	66-75	3	45	59.20	33.12	92.32	0.00	[4]0.00	0.00	59.20	33.12	92.32
		[3]76-85	3	45	82.22	46.00	128.22	0.00	[4]0.00	0.00	82.22	46.00	128.22
		86-95	3	45	105.24	58.88	164.12	0.00	[4]0.00	0.00	105.24	58.88	164.12
Plant[8]	Shortleaf pine	[3]66-75	3	50	42.34	49.48	91.82	0.00	[4]0.00	0.00	42.34	49.48	91.82
		76-85	3	50	55.04	64.32	119.37	0.00	[4]0.00	0.00	55.04	64.32	119.37
		86-95	3	50	67.74	79.17	146.91	0.00	[4]0.00	0.00	67.74	79.17	146.91
Plant	Virginia pine	56-65	0	30	0.00	71.23	71.23	0.00	[9]0.00	0.00	0.00	71.23	71.23
		[3]66-75	0	30	0.00	94.97	94.97	0.00	[9]0.00	0.00	0.00	94.97	94.97
		76-85	0	30	0.00	118.71	118.71	0.00	[9]0.00	0.00	0.00	118.71	118.71
Understory release[10]	Slash pine	[3]66-75	2	30	13.67	55.33	69.00	0.00	0.00	0.00	13.67	55.33	69.00
		76-85	2	30	20.23	81.89	102.12	0.00	0.00	0.00	20.23	81.89	102.12
		86-95	2	30	27.74	112.33	140.07	0.00	0.00	0.00	27.74	112.33	140.07
Understory release[10]	Loblolly pine	66-75	3	45	47.36	27.36	74.72	0.00	0.00	0.00	47.36	27.36	74.72
		[3]76-85	3	45	65.78	38.00	103.78	0.00	0.00	0.00	65.78	38.00	103.78
		86-95	3	45	84.20	48.64	132.84	0.00	0.00	0.00	84.20	48.64	132.84
Understory release[10]	Shortleaf pine	[3]66-75	3	50	33.98	39.50	73.48	0.00	0.00	0.00	33.98	39.50	73.48
		76-85	3	50	44.17	51.35	95.52	0.00	0.00	0.00	44.17	51.35	95.52
		86-95	3	50	54.37	63.20	117.57	0.00	0.00	0.00	54.37	63.20	117.57
Precommercial thin	Slash pine	[3]66-75	2	40	30.95	30.63	61.58	28.18	11.96	40.14	2.77	18.67	21.44
		76-85	2	40	45.81	45.33	91.14	35.23	14.95	50.18	10.58	30.38	40.96
		86-95	2	40	62.83	62.17	125.01	42.27	17.94	60.22	20.56	44.23	64.79
Precommercial thin	Loblolly pine	66-75	3	50	41.06	41.04	82.10	28.22	12.05	40.27	12.84	28.99	41.83
		[3]76-85	3	50	51.32	51.30	102.62	35.28	15.06	50.34	16.04	36.24	52.28
		86-95	3	50	61.58	61.56	123.14	42.34	18.07	60.41	19.24	43.49	62.73
Intermediate[11]	Virginia pine	56-65	0	30	0.00	65.45	65.45	0.00	43.05	43.05	0.00	22.40	22.40
		[3]66-75	0	30	0.00	87.27	87.27	0.00	61.50	61.50	0.00	25.77	25.77
		76-85	0	30	0.00	109.09	109.09	0.00	79.95	79.95	0.00	29.13	29.13
Intermediate[12]	Slash pine	66-75	2	40	42.40	25.92	68.32	28.18	11.96	40.14	14.22	13.96	28.18
		[3]76-85	2	40	53.00	32.40	85.40	35.23	14.95	50.18	17.77	17.45	35.22
		86-95	2	40	76.32	46.66	122.98	48.61	20.63	69.25	27.71	26.03	53.73
Intermediate[12]	Longleaf pine	66-75	3	60	34.53	15.53	50.06	18.21	7.83	26.04	16.32	7.70	24.02
		[3]76-85	3	60	43.17	19.42	62.58	22.77	9.78	32.55	20.40	9.64	30.03
		86-95	3	60	54.39	24.47	78.85	27.32	11.74	39.06	27.07	12.73	39.79
Intermediate[12]	Loblolly pine	66-75	3	50	47.84	29.01	76.85	28.22	12.05	40.27	19.62	16.96	36.58
		[3]76-85	3	50	59.80	36.26	96.06	35.28	15.06	50.34	24.52	21.20	45.72
		86-95	3	50	75.35	45.69	121.04	42.34	18.07	60.41	33.01	27.62	60.63
Intermediate[12]	Shortleaf pine	66-75	4	60	45.99	25.63	71.62	26.27	11.13	37.40	19.72	14.50	34.22
		[3]76-85	4	60	57.48	32.03	89.52	32.83	13.92	46.75	24.65	18.11	42.77
		86-95	4	60	72.43	40.36	112.80	39.40	16.70	56.10	33.03	23.66	56.70
Intermediate[13]	Longleaf pine	66-75	3	60	25.13	13.08	38.20	18.21	7.83	26.04	6.92	5.25	12.16
		[3]76-85	3	60	33.50	17.43	50.93	22.77	9.78	32.55	10.73	7.65	18.38
		86-95	3	60	41.88	21.79	63.66	27.32	11.74	39.06	14.56	10.05	24.60

Appendix Table A4. Continued

Practice	Species	Site index range	Number of thins[1]	Rotation age	Intense			Current			Net Change		
					Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total
Intermediate[13]	Loblolly pine	66-75	2	50	35.79	21.90	57.70	28.22	12.05	40.27	7.57	9.85	17.43
		[3]76-85	2	50	47.72	29.22	76.94	35.28	15.06	50.34	12.44	14.16	26.60
		86-95	2	50	59.65	36.53	96.18	42.34	18.07	60.41	17.31	18.46	35.77
Intermediate[13]	Shortleaf pine	66-75	3	60	34.98	18.75	53.73	26.27	11.13	37.40	8.71	7.62	16.33
		[3]76-85	3	60	46.65	25.00	71.65	32.83	13.92	46.75	13.82	11.08	24.90
		86-95	3	60	58.31	31.25	89.56	39.40	16.70	56.10	18.91	14.55	33.46
Intermediate[14]	Longleaf pine	66-75	2	60	21.37	8.67	30.04	18.21	7.83	26.04	3.16	0.84	4.00
		[3]76-85	2	60	26.72	10.83	37.55	22.77	9.78	32.55	3.95	1.05	5.00
		86-95	2	60	32.06	13.00	45.06	27.32	11.74	39.06	4.74	1.26	6.00
Intermediate[14]	Loblolly pine	66-75	2	[15]60	32.81	13.31	46.12	28.22	12.05	40.27	4.59	1.26	5.85
		[3]76-85	2	[15]60	41.02	16.63	57.65	35.28	15.06	50.34	5.74	1.57	7.31
		86-95	2	[15]60	49.22	19.96	69.18	42.34	18.07	60.41	6.88	1.89	8.77
Intermediate[14]	Shortleaf pine	66-75	2	60	30.56	12.39	42.95	26.27	11.13	37.40	4.29	1.26	5.55
		[3]76-85	2	60	38.20	15.48	53.68	32.83	13.92	46.75	5.37	1.56	6.93
		86-95	2	60	45.84	18.58	64.42	39.40	16.70	56.10	6.44	1.88	8.32
Intermediate[16]	Longleaf pine	66-75	1	60	18.68	8.01	26.69	18.21	7.83	26.04	0.47	0.18	0.65
		[3]76-85	1	60	23.35	10.02	33.37	22.77	9.78	32.55	0.58	0.24	0.82
		86-95	1	60	28.02	12.02	40.04	27.32	11.74	39.06	0.70	0.28	0.98
Intermediate[16]	Loblolly pine	66-75	1	[15]60	28.73	12.32	41.06	28.22	12.05	40.27	0.51	0.27	0.79
		[3]76-85	1	[15]60	35.92	15.40	51.32	35.28	15.06	50.34	0.64	0.34	0.98
		86-95	1	[15]60	43.10	18.48	61.58	42.34	18.07	60.41	0.76	0.41	1.17
Intermediate[16]	Shortleaf pine	66-75	1	60	26.73	11.47	38.20	26.27	11.13	37.40	0.46	0.34	0.80
		[3]76-85	1	60	33.42	14.33	47.75	32.83	13.92	46.75	0.59	0.41	1.00
		86-95	1	60	40.10	17.20	57.30	39.40	16.70	56.10	0.70	0.50	1.20
Intermediate[17]	Oak-pine	[3]56-65	5	[18]100	[19]51.23	45.94	97.17	37.59	35.45	73.04	13.64	10.49	24.13
		66-75	5	[18]100	74.28	66.61	140.90	54.50	51.40	105.91	19.78	15.21	34.99
		76-85	5	[18]100	92.21	82.69	174.91	67.66	63.81	131.47	24.55	18.88	43.44
Plant	White pine	55-64	3	120	93.33	12.50	105.83	[20]0.00	0.00	0.00	93.33	12.50	105.83
		65-74	3	120	118.33	11.66	130.00	0.00	0.00	0.00	118.33	11.66	130.00
		75-84	4	120	146.66	11.66	158.32	0.00	0.00	0.00	146.66	11.66	158.32
Plant	Red pine	60-64	4	120	102.17	20.67	122.83	0.00	0.00	0.00	102.17	20.67	122.83
		70-74	5	120	129.42	24.75	154.17	0.00	0.00	0.00	129.42	24.75	154.17
		80-84	5	120	158.42	23.92	182.33	0.00	0.00	0.00	158.42	23.92	182.33
Plant	Jack pine	36-45	0	60	28.33	11.67	40.00	0.00	0.00	0.00	28.33	11.67	40.00
		46-55	1	60	42.67	13.33	56.00	0.00	0.00	0.00	42.67	13.33	56.00
		56-85	1	60	53.33	16.67	70.00	0.00	0.00	0.00	53.33	16.67	70.00
Plant	Spruce	46-54	2	80	62.50	9.38	71.88	0.00	0.00	0.00	62.50	9.38	71.88
		55-64	3	80	88.75	11.25	100.00	0.00	0.00	0.00	88.75	11.25	100.00
Prune	White pine	45-54	3	120	[21]74.17	8.33	82.50	74.17	8.33	82.50	0.00	0.00	0.00
		55-64	3	120	93.33	12.50	105.83	93.33	12.50	105.83	0.00	0.00	0.00
		65-74	3	120	118.33	11.66	130.00	118.33	11.66	130.00	0.00	0.00	0.00
Prune	Red pine	50-54	3	120	68.17	21.25	89.42	68.17	21.25	89.42	0.00	0.00	0.00
		60-64	4	120	102.17	20.67	122.83	102.17	20.67	122.83	0.00	0.00	0.00
		70-74	5	120	129.42	24.75	154.17	129.42	24.75	154.17	0.00	0.00	0.00
Intermediate[22]	Northern pines	45-54	3	100	[21]75.20	18.32	93.52	56.00	9.60	65.60	19.20	8.72	27.92
		[3]55-64	3	100	94.00	22.90	116.90	70.00	12.00	82.00	24.00	10.90	34.90
		65-74	3	100	112.80	27.48	140.28	84.00	14.40	98.40	28.80	13.08	41.88
Intermediate[23]	Northern pines	45-54	2	100	[21]74.40	16.00	90.40	56.00	9.60	65.60	18.40	6.40	24.80
		[3]55-64	2	100	93.00	20.00	113.00	70.00	12.00	82.00	23.00	8.00	31.00
		65-74	2	100	111.60	24.00	135.60	84.00	14.40	98.40	27.60	9.60	37.20

Appendix Table A4. Continued.

Practice	Species	Site index range	Number of thins[1]	Rotation age	Intense			Current			Net Change		
					Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total
Intermediate[24]	Spruce-fir	[3]50-60	1	70	51.71	46.86	98.57	20.64	41.29	61.93	31.07	5.57	36.64
		60-70	1	70	57.92	52.48	110.40	24.29	48.57	72.86	33.63	3.91	37.54
Intermediate[25]	Spruce-fir	[3]50-60	1	70	38.29	46.86	85.15	20.64	41.29	61.93	17.65	5.57	23.22
		60-70	1	70	42.88	52.48	95.36	24.29	48.57	72.86	18.59	3.91	22.50
Intermediate	Hemlock	[3]45-54	0	100	[21]78.00	0.00	78.00	70.00	12.00	82.00	8.00	-12.00	-4.00
		55-64	0	100	97.50	0.00	97.50	87.50	15.00	102.50	10.00	-15.00	-5.00
Plant	Black walnut	60-74	2	50	47.29	0.00	47.29	0.00	0.00	0.00	47.29	0.00	47.29
		[3]75-84	2	50	55.64	0.00	55.64	0.00	0.00	0.00	55.64	0.00	55.64
		85-94	2	50	63.99	0.00	63.99	0.00	0.00	0.00	63.99	0.00	63.99
Prune	Black walnut	[3]55-64	0	88	13.09	0.00	13.09	13.09	0.00	13.09	0.00	0.00	0.00
		65-74	0	88	15.06	0.00	15.06	15.06	0.00	15.06	0.00	0.00	0.00
		[3]75-84	2	61	26.89	0.00	26.89	26.89	0.00	26.89	0.00	0.00	0.00
Intermediate[28]	Black walnut	[3]55-64	0	[27]88	13.09	0.00	13.09	5.17	0.00	5.17	7.92	0.00	7.92
		65-74	0	[27]88	15.06	0.00	15.06	5.95	0.00	5.95	9.11	0.00	9.11
		[3]75-84	2	61	26.89	0.00	26.89	19.03	0.00	19.03	10.86	0.00	10.86
Intermediate[28]	Oak-hickory	45-54	3	100	23.04	24.34	47.38	9.02	19.14	28.16	14.02	5.20	19.22
		55-64	4	100	28.79	30.96	59.75	13.66	29.00	42.66	15.13	1.96	17.09
		65-84	5	100	44.95	36.90	81.85	20.76	44.08	64.84	24.19	-7.18	17.01
Intermediate	Cove hardwood	85-94	3	70	73.22	6.85	80.06	34.68	7.27	41.95	38.54	-0.42	68.11
		95-104	3	70	106.37	9.94	116.31	50.38	10.56	60.94	55.99	-0.62	55.37
		[3]105-114	3	70	138.14	12.91	151.05	65.43	13.71	79.14	72.71	-0.80	71.91
Intermediate[29]	Northern hardwood[30]	45-54	2	100	[31]33.15	9.35	42.50	20.40	5.95	26.35	12.75	3.40	16.15
		[3]55-64	2	100	39.00	11.00	50.00	24.00	7.00	31.00	15.00	4.00	19.00
		65-74	2	100	44.85	12.65	57.50	27.60	8.05	35.65	17.25	4.60	21.85
Intermediate[32]	Northern hardwood[30]	45-54	2	100	[31]30.60	9.35	39.95	20.40	5.95	26.35	10.20	3.40	13.60
		[3]55-64	2	100	36.00	11.00	47.00	24.00	7.00	31.00	12.00	4.00	16.00
		65-74	2	100	41.40	12.65	54.05	27.60	8.05	35.65	13.80	4.60	18.40
Intermediate[33]	Northern hardwood[30]	45-54	2	108	[31]28.33	8.66	36.99	20.40	5.95	26.35	7.93	2.71	10.64
		[3]55-64	2	108	33.33	10.19	43.52	24.00	7.00	31.00	9.33	3.19	12.52
		65-74	2	108	38.33	11.71	50.04	27.60	8.05	35.65	10.73	3.66	14.39
Intermediate[34]	Northern hardwood[35]	50-60	0	[36]12	33.33	6.67	40.00	32.00	0.00	32.00	1.33	6.67	8.00
		[3]61-70	0	12	41.67	8.33	50.00	40.00	0.00	40.00	1.67	8.33	10.00
		71-80	0	12	50.00	10.00	60.00	48.00	0.00	48.00	2.00	10.00	12.00
Intermediate[37]	Northern hardwood[35]	50-60	0	[38]12	31.66	6.72	38.38	18.29	0.00	18.29	13.37	6.72	20.09
		[3]61-70	0	12	39.58	7.91	47.49	22.86	0.00	22.86	16.72	7.91	24.63
		71-80	0	12	47.50	9.49	56.99	27.43	0.00	27.43	20.07	9.49	29.56
Intermediate[39]	Northern hardwood[35]	50-60	0	[40]12	30.00	6.00	36.00	12.80	0.00	12.80	17.20	6.00	23.20
		[3]61-70	0	12	37.50	7.50	45.00	16.00	0.00	16.00	21.50	7.50	29.00
		71-80	0	12	45.00	9.00	54.00	19.20	0.00	19.20	25.80	9.00	34.80
Intermediate	White birch	50-69	1	[41]65	98.46	0.00	98.46	35.29	0.00	35.29	63.17	0.00	63.17
		70-90	1	[42]45	142.22	0.00	142.22	50.00	0.00	50.00	92.22	0.00	92.22
Plant[43]	Douglas-fir[44]	130	1	[45]50	157.80	36.60	194.40	48.60	0.00	48.60	109.20	36.60	145.80
		160	1	[45]50	215.20	58.20	273.40	74.20	0.00	74.20	141.00	58.20	199.20
		170	1	[45]50	217.60	74.40	292.00	78.30	0.00	78.30	139.30	74.40	213.70
Intermediate[43]	Douglas-fir[44]	100	1	70	107.10	0.00	107.10	78.60	0.00	78.60	28.50	0.00	28.50
		140	1	50	150.00	32.00	182.00	66.70	0.00	66.70	83.33	32.00	115.30
		170	1	50	213.00	71.00	284.00	78.30	0.00	78.30	134.70	71.00	205.70
Plant[43]	Ponderosa	110	3	120	27.40	0.00	27.40	0.00	0.00	0.00	27.40	0.00	27.40
Intermediate[43]	Douglas-fir[45]	50	1	110	31.00	0.00	31.00	11.00	0.00	11.00	20.00	0.00	20.00
		70	1	110	30.90	0.00	30.90	17.70	0.00	17.70	13.20	0.00	13.20

Appendix Table A4. Continued.

Practice	Species	Site index range	Number of thins[1]	Rotation age	Intense			Current			Net Change		
					Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total	Sawtimber	Pulpwood	Total
Intermediate[43]	Ponderosa	60	1	120	23.80	0.00	23.80	22.00	0.00	22.00	1.80	0.00	1.80
		80	1	110	25.70	0.00	25.70	15.60	0.00	15.60	10.10	0.00	10.10
Intermediate[43]	Lodgepole	65	1	140	23.50	0.00	23.50	23.40	0.00	23.40	0.10	0.00	0.10

[1]*The number of commercial thins for the first rotation of the intense regime.*
[2]*Planting bare land or planting after an intense site preparation; when planting after a less intense site preparation all yields are reduced by 10%.*
[3]*This is the base regime from which all adjustments are made.*
[4]*This is the MAI when there was an intense site preparation or when there are less than 200 conifer volunteers; for a less intense site preparation or bare land planting and greater than 199 conifer volunteers, the MAI is 20.00 cubic feet/acre/year of pulpwood on a thirty year rotation.*
[5]*Planting after a less intense site preparation.*
[6]*Planting bare land or after an intense site preparation.*
[7]*Planting bare land or after an intense site preparation; when planting after a less intense site preparation all yields are reduced by 20%.*
[8]*Planting bare land or after an intense site preparation; when planting after a less intense site preparation all yields are reduced by 30%.*
[9]*This is the MAI when there was an intense site preparation or when there are less than 250 conifer volunteers; for a less intense site preparation or bare land planting and greater than 249 conifer volunteers the MAI is 14.23 cubic feet/acre/year of pulpwood on a thirty year rotation.*
[10]*MAI's when there are 200-1499 established pine.*
[11]*Practice done in a stand that was 0-10 years old after treatment.*
[12]*Practice done in a stand that was 11-20 years old after treatment.*
[13]*Practice done in a stand that was 21-30 years old after treatment.*
[14]*Practice done in a stand that was 31-35 years old after treatment.*
[15]*Rotation age for the current regime is 50 years.*
[16]*Practice done in a stand that was 36-40 years old.*
[17]*Intermediate treatment in a stand where the hardwood basal area was between 30 and 49 square feet.*
[18]*The rotation age for the current regime is 80 years.*
[19]*The MAI's are for hardwood and softwood yields combined.*
[20]*This is the MAI when there was an intense site preparation or when there are less than 200 conifer volunteers; for a less intense site preparation or bare land planting and greater than 199 conifer volunteers, the MAI is 14.08 cubic feet/acre/year on a 120 year rotation.*
[21]*MAI for the softwood yield only, hardwood not included*
[22]*Practice done in a stand that was 0-34 years old after treatment.*
[23]*Practice done in a stand that was 35-60 years old after treatment.*
[24]*Practice done in a stand that was 10-24 years old after treatment.*
[25]*Practice done in a stand that was 25-50 years old after treatment.*
[26]*MAI's for stands where there are greater than 43 black walnut trees per acre; yield reductions are made for less than 44 black walnut trees.*
[27]*The rotation age of the current regime is 75 years.*
[28]*MAI's when stand was 0-39 years old after treatment.*
[29]*Practice done in a stand that was 0-34 years old.*
[30]*Northern hardwoods in the northeast managed under a clearcut system.*
[31]*MAI for the hardwood yield only, conifer not included.*
[32]*Practice done in a stand that was 45-50 years old after treatment.*
[33]*Practice done in a stand that was 56-60 years old after treatment.*
[34]*Intermediate treatment in stands that were 10-25 inches D.B.H. at time of treatment.*
[35]*Northern hardwoods in the Lake states, managed under a selection cut system.*
[36]*The intense regime has a selection cut every 12 years; the current regime has a rotation age of 20 years.*
[37]*Intermediate treatment in stands that were 6-9 inches D.B.H. at the time of treatment.*
[38]*The intense regime has a selection cut every 12 years; the current regime has a rotation age of 35 years.*
[39]*Intermediate treatment in stands that were 1-5 inches D.B.H. at the time of treatment.*
[40]*The intense regime has a selection cut every 12 years; the current regime has a rotation age of 50 years.*
[41]*The rotation age of the current regime is 85 years.*
[42]*The rotation age of the current regime is 60 years.*
[43]*These MAI's are for specific representative cases instead of stylized regimes.*
[44]*Applies to Douglas-fir on the West Coast.*
[45]*Applies to Douglas-fir in the Rocky Mountains.*

Appendix Table A5. Sample case management regime with yields, stumpage prices, and treatments costs for a site preparation and planting case

Basic case identification information:

Sample number: 14,820
State: Georgia
Site index: 70
Pre-treatment stand age: 30
Cost region: 4
Regime number (intense): 11,004
County: Screven
Acres treated: 52
Treatment: Site preparation and plant
Price region: 10
Regime number (current): 11,102
Species group: Loblolly pine
Total surviving planted: 381
Cost option: Total direct

Management regime with yields, costs, and prices:

	Transaction number	Investment year[1]	Cost	Yield	Sensitivity group code[2]	Stumpage price	Sensitivity group code[3]	Perpetuity year[4]	Harvest code[5]	Item description	Stand age at harvest
			($)	*(1,000 cu ft/ac)*		*($/1,000 cu ft)*					*(years)*
Intense regime:											
First rotation—	1	0	64.10	—	—	—	—	—	9	Site preparation and planting	—
	2	4	15.00	—	2	—	—	—	—	Hardwood control	—
	3	10	2.50	—	2	—	—	—	—	Prescribe burn	—
	4	17	—	.47	4	169.46	6	—	2	Commercial thin	—
	5	25	—	.56	4	169.46	6	—	2	Commercial thin	—
	6	35	—	.58	4	529.27	6	—	1	Commercial thin	—
	7	35	—	.25	4	169.46	6	—	2	Commercial thin	—
	8	45	—	2.48	5	529.27	6	—	1	Final harvest	45
	9	45	—	.22	5	169.46	6	—	2	Final harvest	45
Perpetual rotation—	10	45	66.62	—	—	—	—	45	—	Site preparation and planting	—
	11	55	2.50	—	—	—	—	45	—	Prescribe burn	—
	12	62	—	.54	—	169.46	—	45	—	Commercial thin	—
	13	70	—	.54	—	169.46	—	45	—	Commercial thin	—
	14	80	—	.50	—	529.27	—	45	—	Commercial thin	—
	15	80	—	.22	—	169.46	—	45	—	Commercial thin	—
	16	90	—	2.16	—	529.27	—	45	—	Final harvest	—
	17	90	—	.19	—	169.46	—	45	—	Final harvest	—
Current regime[6]:	—	—	—	—	—	—	—	—	—	—	—

Appendix Table A5. Continued

Mean annual increments in cubic feet/acre/year:

	Intense	Current	Net Change
Sawtimber	68.09	0.00	68.09
Pulpwood	33.24	0.00	33.24
Total	101.33	0.00	101.33

Adjustments made to the stylized regime:

	Adjustment parameter	Threshold class	Case value	Adjustment[7] factor	Treatments adjusted
Intense regime:	01 (site index)	60 sq. ft.-75 sq. ft.	70 sq. ft.	.72	3,906 (all harvests, all yields)
	02 (number of surviving planted conifer)	300-399 planted conifer	381 planted conifer	.75	1,713 (first rotation, first commercial thin, softwood pulpwood yield)
	02 (number of surviving planted conifer)	300-399 planted conifer	381 planted conifer	.90	1,723 (first rotation, second commercial thin, softwood pulpwood yield)
	07 (improved seedlings planted)	1 (yes, improved seedlings planted)	1 (yes, improved seedlings planted)	1.15	1,906 (first rotation, all harvests, all yields)
Current regime:	10 (intense method of site preparation)	1 (yes, intense site preparation)	1 (yes, intense site preparation)	.00	3,906 (all harvests, all yields)
	03 (number of volunteer pine)	0-199 volunteer pine	0 volunteer pine	.00	3,906 (all harvests, all yields)

[1]*Investment year is the number of years from the time the FIP treatment was installed.*

[2]*These are the codes assigned to the subsequent treatments costs, commercial thin, and final harvest yields for use in the sensitivity analysis.*

[3]*These are the codes assigned to the stumpage prices for use in the sensitivity analysis.*

[4]*Perpetuity year is the number of years until the treatment is repeated on a continued basis.*

[5]*The harvest codes are: 1 = softwood sawtimber, intense regime; 2 = softwood pulpwood, intense regime; 3 = hardwood sawtimber, intense regime; 4 = hardwood pulpwood, intense regime; 5 = softwood sawtimber, current regime; 6 = softwood pulpwood, current regime; 7 = hardwood sawtimber, current regime; 8 = hardwood pulpwood, current regime; 9 = the FIP treatment.*

[6]*No current regime because of the intense site preparation, even though there was a stand before treatment, it was assumed that the pretreatment stands in southern pine planting cases were of no value.*

[7]*The yield or the treatment under "Treatments adjusted" is increased or decreased, or eliminated by the adjustment factor.*

Appendix Table A6. Sample case management regime with yields, stumpage prices, and treatment costs for a timber stand improvement case

Basic case identification information:

Sample number: 58,511
State: New Hampshire
Site index: 70
Pre-treatment stand age: 50
Cost region: 1
Regime number (intense): 11,004

County: Grafton
Acres treated: 4
Treatment: Intermediate treatment
Price region: 01
Regime number (current): 23,132

Species group: Northern Hardwood
Cost option: Total direct

Management regime with yields, costs, and prices:

	Transaction number	Investment year[1]	Cost	Yield	Sensitivity group code[2]	Stumpage price	Sensitivity group code[3]	Perpetuity year[4]	Harvest code[5]	Item description	Stand age at harvest
			($)	*(1,000 cu ft/ac)*		*($/1,000 cu ft)*					*(years)*
Intense regime:											
First rotation—	1	0	36.00	—	—	—	—	—	9	Intermediate treatment	—
	2	10	—	.50	4	314.43	6	—	3	Commercial thin	—
	3	10	—	.15	4	45.04	6	—	4	Commercial thin	—
	4	30	—	.80	4	314.43	6	—	3	Commercial thin	—
	5	30	—	.25	4	45.04	6	—	4	Commercial thin	—
	6	50	—	2.64	5	314.43	6	—	3	Final harvest	100
	7	50	—	.80	5	45.04	6	—	4	Final harvest	100
Perpetual rotation—	8	60	31.39	—	—	—	—	100	—	Precommercial thin	—
	9	80	31.39	—	—	—	—	100	—	Intermediate treatment	—
	10	100	31.39	—	—	—	—	100	—	Intermediate treatment	—
	11	110	—	.80	—	314.43	—	100	—	Commercial thin	—
	12	110	—	.25	—	45.04	—	100	—	Commercial thin	—
	13	130	—	.90	—	314.43	—	100	—	Commercial thin	—
	14	130	—	.30	—	45.04	—	100	—	Commercial thin	—
	15	150	—	2.64	—	314.43	—	100	—	Final harvest	—
	16	150	—	.80	—	45.04	—	100	—	Final harvest	—
Current regime:											
First rotation—	17	50	—	-2.76	—	271.19	—	—	7	Final harvest	100
	18	50	—	-.80	—	45.04	—	—	8	Final harvest	100
Perpetual rotation—	19	90	—	-1.15	—	271.19	—	40	—	Final harvest	—
	20	90	—	-.34	—	45.04	—	40	—	Final harvest	—

Appendix Table A6. Continued.

Mean annual increments in cubic feet/acre/year:

	Intense	Current	Net change
Sawtimber	39.45	27.60	11.85
Pulpwood	12.05	8.05	4.00
Total	51.50	35.65	15.85

Adjustments made to the stylized regime:

	Adjustment parameter	Threshold class	Case value	Adjustment factor[6]	Treatments adjusted
Intense regime:	01 (site index)	65 sq. ft.-74 sq. ft.	70 sq. ft.	1.15	3,816 (final harvest, all yields)
	37 (percent of post-treatment crop basal area in conifer)	0 percent	0 percent	0.00	1,812 (first rotation, final harvest, softwood sawtimber)
Current regime:	01 (site index)	65 sq. ft.-74 sq. ft.	70 sq. ft.	1.15	3,816 (final harvest, all yields)
	36 (percent of pre-treatment crop basal area in conifer)	0 percent	0 percent	0.00	1,812 (first rotation, final harvest, softwood sawtimber)

[1]*Investment year is the number of years from the time the FIP treatment was installed.*

[2]*These are the codes assigned to the subsequent treatments costs, commercial thin, and final harvest yields for use in the sensitivity analysis.*

[3]*These are the codes assigned to the stumpage prices for use in the sensitivity analysis.*

[4]*Perpetuity year is the number of years until the treatment is repeated on a continued basis.*

[5]*The harvest codes are: 1 = softwood sawtimber, intense regime; 2 = softwood pulpwood, intense regime; 3 = hardwood sawtimber, intense regime; 4 = hardwood pulpwood, intense regime; 5 = softwood sawtimber, current regime; 6 = softwood pulpwood, current regime; 7 = hardwood sawtimber, current regime; 8 = hardwood pulpwood, current regime; 9 = the FIP treatment.*

[6]*The yield or the treatment under "Treatments adjusted" is increased or decreased, or eliminated by the adjustment factor.*

Appendix Table A7. Stylized stumpage prices in dollars per 1,000 cubic feet by species, product and region

Species	Product	Region[1]												
		1	2	3	4	5	6	7	8	9	10	11	12	13
Eastern white pine[2]	sawtimber	227.15	263.70	173.00	193.62	173.00	193.62	193.62	265.47	372.94	433.62	—	—	—
	pulpwood	27.96	27.64	46.66	55.94	46.66	55.94	55.94	65.66	74.93	169.46	—	—	—
Red pine[3]	sawtimber	219.16	254.43	166.92	186.81	—	—	186.81	—	177.40	—	—	—	—
	pulpwood	46.28	45.77	45.77	92.62	—	—	92.62	—	51.60	—	—	—	—
Jack pine	sawtimber	170.74	198.22	130.04	145.54	—	198.22	145.54	—	—	—	—	—	—
	pulpwood	48.31	47.78	47.78	92.62	—	47.78	96.68	—	—	—	—	—	—
Shortleaf pine	sawtimber	—	—	158.77	—	236.46	195.85	—	243.65	434.42	529.27	508.23	600.91	428.75
	pulpwood	—	—	50.04	—	41.00	33.96	—	65.66	74.93	169.46	95.97	81.23	72.69
Slash pine	sawtimber	—	—	158.77	—	236.46	195.85	—	243.65	434.42	529.27	508.23	600.91	428.75
	pulpwood	—	—	50.04	—	41.00	33.96	—	65.66	74.93	169.46	95.97	81.23	72.69
Virginia pine	sawtimber	—	88.95	88.95	—	133.10	110.24	—	136.49	143.39	174.70	167.76	198.35	241.33
	pulpwood	—	50.04	50.04	—	41.00	33.96	—	65.66	74.93	169.46	95.97	81.23	72.69
Loblolly pine	sawtimber	—	—	158.77	—	236.46	195.85	—	243.65	434.42	529.27	508.23	600.91	428.75
	pulpwood	—	—	50.04	—	41.00	33.96	—	65.66	74.93	169.46	95.97	81.23	72.69
Longleaf pine	sawtimber	—	—	158.77	—	236.46	195.85	—	243.65	725.67	773.10	762.58	808.91	722.83
	pulpwood	—	—	50.04	—	41.00	33.96	—	65.66	402.93	450.19	413.45	406.09	401.82
Other southern pines	sawtimber	—	—	88.95	—	133.10	110.24	—	136.49	143.39	174.70	167.76	198.35	241.33
	pulpwood	—	—	50.04	—	41.00	33.96	—	65.66	74.93	169.46	95.97	81.23	72.69
Black spruce	sawtimber	193.53	210.91	137.55	—	—	—	131.79	—	137.55	—	—	—	—
	pulpwood	77.16	63.93	63.93	—	—	—	108.60	—	63.93	—	—	—	—
Red spruce	sawtimber	193.53	210.91	137.55	—	—	—	131.79	—	—	—	—	—	—
	pulpwood	77.16	63.93	63.93	—	—	—	108.60	—	—	—	—	—	—
White spruce	sawtimber	193.53	210.91	137.55	131.79	—	—	131.79	131.79	—	—	—	—	—
	pulpwood	77.16	63.93	63.93	108.60	—	—	108.60	108.60	—	—	—	—	—
Balsam fir	sawtimber	193.53	—	—	—	—	—	131.79	—	—	—	—	—	—
	pulpwood	77.16	—	—	—	—	—	68.38	—	—	—	—	—	—
Other true firs	sawtimber	193.53	—	—	—	—	—	—	—	—	—	—	—	—
	pulpwood	77.16	—	—	—	—	—	—	—	—	—	—	—	—
Tamarack	sawtimber	199.07	234.99	177.40	—	—	—	154.45	—	—	—	—	—	—
	pulpwood	42.65	27.65	51.60	—	—	—	48.73	—	—	—	—	—	—
Eastern hemlock	sawtimber	167.51	210.91	158.77	137.29	209.08	—	137.29	127.54	—	—	—	—	—
	pulpwood	42.65	82.92	50.04	69.95	41.00	—	69.95	65.66	—	—	—	—	—
Other northern conifers	sawtimber	199.07	234.99	177.40	154.45	191.04	154.45	154.45	—	177.40	—	—	—	—
	pulpwood	55.86	27.64	51.60	37.34	43.83	37.34	37.34	—	51.60	—	—	—	—
White oak	sawtimber	243.29	448.03	277.55	514.69	424.16	235.13	243.75	211.91	141.53	164.35	268.54	299.23	299.23
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	23.32	13.82	26.51	54.85	59.54	35.65	13.82
Southern red oak	sawtimber	—	—	268.97	451.02	314.40	188.95	—	433.43	255.42	262.12	428.28	477.22	477.22
	pulpwood	—	—	39.96	33.97	24.76	23.19	—	13.82	26.51	54.85	59.54	35.65	13.82
Northern red oak	sawtimber	234.14	495.52	268.97	451.02	314.40	188.95	240.50	433.43	225.42	262.12	—	—	477.22
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	23.32	13.82	26.51	54.85	—	—	13.82
Other oaks	sawtimber	173.84	258.46	192.05	234.88	189.49	158.90	219.82	140.38	147.44	118.79	250.96	277.07	250.96
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	21.62	13.82	26.51	54.85	59.54	35.65	13.82
Yellow poplar	sawtimber	220.21	431.63	260.72	601.30	340.89	426.65	—	433.98	249.42	118.79	194.90	352.77	352.77
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	—	13.82	26.51	54.85	59.54	35.65	13.82

Appendix Table A7. Continued.

Species	Product	Region[1] 1	2	3	4	5	6	7	8	9	10	11	12	13
All hickories	sawtimber	173.44	279.95	192.05	234.88	186.15	158.90	140.56	140.30	147.44	118.79	166.07	166.07	158.03
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	21.62	13.82	26.51	54.85	59.54	35.65	13.82
Black walnut[4]	sawtimber	—	4019.08	2595.11	3819.96	3354.91	3927.38	3419.10	2849.25	2595.11	—	—	166.07	—
	pulpwood	—	37.20	39.96	33.97	24.76	23.19	21.62	13.82	26.51	—	—	35.65	—
Butternut	sawtimber	—	395.23	—	—	—	—	321.47	—	—	—	—	—	—
	pulpwood	—	37.20	—	—	—	—	21.62	—	—	—	—	—	—
American elm	sawtimber	—	345.84	191.26	254.11	204.88	158.90	211.63	—	—	—	202.20	—	—
	pulpwood	—	37.20	39.96	33.97	24.76	23.19	21.62	—	—	—	59.54	—	—
Black cherry	sawtimber	335.20	648.97	304.05	548.63	294.62	294.62	294.62	298.68	—	—	—	—	—
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	21.62	13.82	—	—	—	—	—
Basswood	sawtimber	166.61	466.79	256.28	446.81	289.58	—	284.61	—	214.78	—	—	—	—
	pulpwood	45.04	37.20	39.96	33.97	24.76	—	42.71	—	26.51	—	—	—	—
White ash	sawtimber	226.46	644.85	367.59	561.07	306.41	234.29	162.18	304.34	367.59	—	202.20	—	158.03
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	21.62	13.82	26.51	—	59.54	—	13.82
Beech	sawtimber	145.02	263.57	148.03	241.70	199.78	—	219.82	—	147.44	—	—	166.07	—
	pulpwood	45.04	37.20	39.96	33.97	24.76	—	21.62	—	26.51	—	—	35.65	—
Yellow birch	sawtimber	482.07	678.91	318.07	541.91	256.42	—	519.14	—	285.45	—	—	—	—
	pulpwood	45.04	66.94	39.96	33.97	24.76	—	31.57	—	26.51	—	—	—	—
White birch	sawtimber	284.95	395.23	192.05	291.80	—	—	188.38	—	—	—	—	—	—
	pulpwood	45.04	66.94	39.96	33.97	—	—	31.57	—	—	—	—	—	—
Hard maple	sawtimber	329.40	704.49	376.98	685.29	324.26	407.06	279.82	312.11	334.44	118.79	—	—	—
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	21.62	13.82	26.51	54.85	—	—	—
Soft maple	sawtimber	189.90	432.56	288.72	421.43	279.88	351.34	197.42	239.05	288.72	118.79	—	—	—
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	21.62	13.82	26.51	54.85	—	—	—
Quaking aspen	sawtimber	152.33	231.39	231.39	118.16	—	—	118.16	—	—	—	—	—	—
	pulpwood	12.29	53.06	53.06	38.38	—	—	38.38	—	—	—	—	—	—
Eastern cottonwood	sawtimber	—	—	174.30	189.45	231.87	162.18	146.46	—	174.30	—	—	166.07	—
	pulpwood	—	—	39.96	38.38	24.76	23.19	38.38	—	26.51	—	—	35.65	—
Sweetgum	sawtimber	—	—	174.30	234.88	228.73	—	—	249.50	174.30	118.79	359.57	359.57	359.57
	pulpwood	—	—	39.96	38.38	24.76	—	—	13.82	26.51	54.85	59.54	35.65	13.82
Other gums	sawtimber	—	258.46	174.30	234.88	239.08	—	—	—	—	359.57	359.57	—	359.57
	pulpwood	—	53.06	39.96	38.38	24.76	—	—	—	—	54.85	59.54	—	13.82
Other hardwood	sawtimber	173.44	258.46	192.05	234.88	220.34	158.90	219.82	140.30	147.44	118.79	202.20	166.07	158.00
	pulpwood	45.04	37.20	39.96	33.97	24.76	23.19	21.62	13.82	26.51	54.85	59.54	35.65	13.82
Eastern white pine, pruned[5]	sawtimber	312.63	377.44	247.62	411.96	—	—	411.96	—	533.00	—	—	—	—
	pulpwood	27.96	27.64	46.66	55.94	—	—	55.94	—	74.93	—	—	—	—
Red pine, pruned[6]	sawtimber	301.63	364.17	238.92	330.93	—	—	330.93	—	—	—	—	—	—
	pulpwood	46.28	45.77	45.77	92.62	—	—	92.62	—	—	—	—	—	—
Black walnut, pruned[7]	sawtimber	—	12497.40	9207.99	12472.51	11526.69	12485.61	10200.97	9239.43	9239.43	—	—	—	—
	pulpwood	—	37.20	39.96	33.97	24.76	23.19	21.62	13.82	13.82	—	—	—	—

Appendix Table A7. Continued.

Species	Product	Region[8] 1	2	3	5	6
Douglas-fir	sawtimber	77.85	—	—	372.00	625.00
	pulpwood	—	—	—	—	417.88
Ponderosa pine	sawtimber	167.55	54.65	251.00	468.30	—
	pulpwood	—	—	—	—	—
Jeffrey pine	sawtimber	—	—	—	468.30	—
	pulpwood	—	—	—	—	—
Sugar pine	sawtimber	—	—	—	487.15	—
	pulpwood	—	—	—	—	—
Lodgepole pine	sawtimber	40.50	108.25	—	69.30	—
	pulpwood	—	—	—	—	—
Engelmann spruce	sawtimber	131.30	—	—	—	—
	pulpwood	—	—	—	—	—
Western red cedar	sawtimber	92.40	—	—	463.80	—
	pulpwood	—	—	—	—	—
True firs	sawtimber	60.90	—	—	219.30	—
	pulpwood	—	—	—	—	—
Western larch	sawtimber	134.00	—	—	—	—
	pulpwood	—	—	—	—	—

[1]*For regional delineations see figure 3 showing the stylized stumpage price regions in the East.*
[2]*Stumpage price for non-pruned eastern white pine.*
[3]*Stumpage price for non-pruned red pine.*
[4]*Stumpage price for non-pruned black walnut.*
[5]*Stumpage price for pruned eastern white pine.*
[6]*Stumpage price for pruned red pine.*
[7]*Stumpage price for pruned black walnut.*
[8]*These regions refer to the Forest Service administrative units.*

Appendix Table A8. Percentages by which the posttreatment stumpage prices differ from the pretreatment prices, by species and region

Species	Region[1] 1	2	3 + 8	4	5	6 + 13	7
White oak	20	20	22	27	25	20	39
Southern red oak	—	18	23	26	22	19	—
Northern red oak	19	18	23	26	22	19	25
Other oaks	16	15	20	23	19	16	22
Yellow poplar	12	12	24	23	22	20	—
All hickories	21	21	21	21	22	21	20
Black walnut	—	26	28	21	27	27	37
Butternut	—	20	—	—	—	—	20
American elm	—	24	26	26	21	15	28
Black cherry	18	20	24	23	22	20	20
Basswood	20	16	24	22	27	—	25
White ash	19	17	22	28	26	26	27
Beech	28	19	24	17	17	—	19
Yellow birch	16	19	18	18	18	—	17
White birch	17	17	17	17	—	—	26
Hard maple	16	21	26	26	20	20	22
Soft maple	14	19	23	23	23	11	37
Aspen	12	12	12	12	—	—	32
Cottonwood	—	—	21	21	21	13	25
Sweetgum	—	—	21	20	19	—	—
Other gums	—	21	21	20	19	—	—
Other hardwoods	17	19	21	27	19	15	20

[1]*For regional delineations see figure 3 showing the stylized stumpage price regions in the East.*

Appendix Table A9. Average subsequent treatment costs in dollars per acre by species group and region

Practice	Species group	Region[1]			
		South	Central	Northeast	Lake
Site preparation and planting	Southern pine[2]	[3]62.18 [4]66.62	59.19	59.19	—
	Oak-pine	66.62	75.00	59.19	—
	Northern pine[5]	84.01	61.14	47.76	57.51
	Other northern conifer[6]	36.86	36.86	36.86	55.16
	Black walnut	62.57	81.53	29.20	50.88
Hardwood control	Southern pine	15.00	15.00	15.00	—
	Northern pine	15.00	15.00	15.00	15.00
	Other northern conifer	15.00	15.00	15.00	15.00
	Black walnut	15.00	15.00	15.00	15.00
Prescribe burn	Southern pine	2.50	2.50	2.50	—
Precommercial thin	Southern pine	22.00	22.00	22.00	—
	Black walnut	15.00	15.00	15.00	15.00
	Northern hardwood	—	40.96	31.39	—
	White birch	—	26.40	26.40	26.40
Intermediate	Southern pine	24.54	24.21	—	—
	Other northern conifer	25.77	25.77	25.77	25.77
	Oak-hickory	29.71	25.29	42.82	49.77
	Black walnut	[7]22.00 [8]29.71	[7]22.00 [8]25.29	[7]22.00 [8]42.82	[7]22.00 [8]49.77
	Cove hardwood	29.71	25.29	42.82	49.77
	Northern hardwood	—	40.96	31.39	30.35
	White birch	—	23.76	23.76	23.76
Prune	Northern pine	36.67	58.14	36.67	24.35
	Black walnut	[7]12.00 [8]16.02	[7]12.00 [8]16.02	[7]12.00 [8]16.02	[7]12.00 [8]17.75

Practice	Region[9]				
	R-1	R-2	R-3	R-5	R-6
Planting	85.00	[10]200.00	150.00	90.00	65.00
Precommercial thin	60.00	60.00	11.50	78.00	40.00
Spray (brush control)	—	—	—	—	25.00
Release	—	—	—	31.00	—

[1]*The regions include the following states: South—Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas, Maryland, Delaware, Virginia, North Carolina, South Carolina; Central—West Virginia, Kentucky, Tennessee, Ohio, Indiana, Illinois, Iowa, Missouri; Northeast—Pennsylvania, New York, Massachusetts, Connecticut, New Jersey, Rhode Island, Maine, New Hampshire, Vermont; Lake—Michigan, Minnesota, Wisconsin.*

[2]*Southern pine includes longleaf, slash, loblolly, shortleaf, Virginia pines.*

[3]*Cost for longleaf and slash pines.*

[4]*Cost for loblolly, shortleaf, Virginia pines.*

[5]*Northern pine includes white, red, and jack pine, and hemlock.*

[6]*Other northern conifer includes spruce and spruce-fir.*

[7]*Cost for black walnut plantations.*

[8]*Cost for natural stands of black walnut.*

[9]*These regions refer to the Forest Service administrative regions.*

[10]*This is the cost for the Rocky Mountain area; the Black Hills cost is $150/acre.*

Appendix Table A10. Average percentage data changes necessary to raise or lower the IROR by 1 percent of interest, by sample cell and three data groups

Sample cell number[1]	Simple average IROR[2]	Upper IROR threshold[3]				Lower IROR threshold[4]			
		Subsequent treatment cost	Commercial thin yield	Final harvest yield	Stumpage price	Subsequent treatment cost	Commercial thin yield	Final harvest yield	Stumpage price
1	14.7	-946	40	118	29	1,089	-36	-73	-23
2	14.0	-907	41	135	30	1,056	-37	-81	-24
3	17.4	-840	32	70	19	886	-30	-50	-17
4	17.4	-844	28	132	21	905	-26	-83	-18
5	14.3	-1,076	51	108	33	1,268	-44	-67	-25
6	14.9	-995	38	135	29	1,145	-34	-82	-23
7	12.6	-1,053	46	151	32	1,250	-41	-90	-25
8	17.0	-766	28	282	24	844	-25	-157	-20
9	13.1	-1,287	56	97	34	1,527	-50	-62	-26
10	14.2	-777	42	132	30	908	-37	-79	-24
11	11.4	-1,971	58	98	35	2,373	-52	-63	-28
12	10.5	-1,544	71	94	39	1,918	-63	-61	-30
13	13.0	-1,364	59	53	25	1,529	-58	-41	-22
14	12.1	-1,330	51	65	27	1,476	-49	-46	-22
15	11.6	-1,790	60	149	36	2,193	-54	-88	-28
16	12.2	-1,387	62	143	32	1,641	-59	-87	-26
17	9.5	-2,069	74	116	41	2,611	-67	-73	-32
18	9.9	-1,831	68	96	39	2,277	-61	-63	-31
19	12.1	-1,863	46	119	31	2,184	-41	-74	-25
20	9.8	-3,202	102	84	40	4,030	-100	-57	-32
21	11.6	-1,307	55	102	35	1,586	-50	-64	-27
22	11.8	-346	37	802	22	483	-36	-348	-17
23	10.6	-726	57	99	34	881	-81	-81	-38
24	19.7	-729	21	253	15	779	-19	-160	-13
25	13.2	-836	45	128	31	984	-39	-81	-25
26	12.6	-323	48	121	33	387	-42	-77	-26
27	10.2	-370	47	120	31	455	-43	-75	-25
28	12.4	-429	51	106	33	515	-46	-70	-26
29	13.3	-390	43	103	29	460	-38	-65	-24
30	13.5	—	12	74	10	—	-10	-47	-8
31	17.0	—	28	88	18	—	-26	-58	-15
32	24.7	—	15	322	10	—	-14	-204	-9
33	20.3	—	20	221	12	—	-20	-93	-10
34	6.4	—	100	1,584	94	—	-61	-360	-52
35	8.2	-1,523	94	172	54	2,016	-90	-120	-80
36	7.7	-1,979	100	94	48	2,598	-95	-64	-38
37	11.5	-693	42	78	26	819	-39	-49	-21
38	13.2	-794	39	90	19	931	-47	-62	-17
39	8.2	—	60	20,704	58	—	-42	-3,606	-37
40	7.3	—	82	10,973	69	—	-61	-1,948	-44
41	7.4	—	83	3,250	70	—	-59	-645	-44
42	8.4	-153	84	21,380	65	221	-59	-3,762	-40
43	8.1	—	60	12,413	58	—	-43	-2,199	-38
44	7.2	-353	70	6,220	66	652	-50	-1,145	-42
45	6.9	-281	89	3,289	81	419	-58	-641	-47
46	11.9	—	27	13,349	21	—	-24	-7,140	-15
47	10.5	—	27	303	21	—	-23	-135	-16
48	12.5	-458	9	740,688	9	424	-8	-200,308	-8
49	12.4	-374	7	77,049	7	352	-6	-19,315	-6
50	15.8	—	22	262	18	—	-20	-138	-14
51	17.0	—	21	735,875	22	—	-18	-537,799	-18
52	10.6	-186	33	115	37	313	-32	-59	-28
53	13.0	-290	31	155	19	301	-28	-71	-16
54	10.4	—	43	121	33	—	-40	-57	-24
55	12.7	-348	—	11	11	319	—	-12	-12
56	18.8	—	16	17,302	15	—	-14	-9,023	-13
57	18.1	—	27	773	20	—	-24	-349	-17
58	11.9	—	35	428	25	—	-31	-200	-19
59	23.3	—	15	39,798	15	—	-13	-20,977	-12
60	19.1	-506	20	35,292	18	478	-17	-19,120	-15

Appendix Table A10. Continued.

Sample cell number[1]	Simple average IROR[2]	Upper IROR threshold[3]				Lower IROR threshold[4]			
		Subsequent treatment cost	Commercial thin yield	Final harvest yield	Stumpage price	Subsequent treatment cost	Commercial thin yield	Final harvest yield	Stumpage price
61	13.2	-337	—	46	13	289	—	-32	-12
62	22.7	-298	17	155,569	16	294	-14	-85,539	-14
63	7.2	-210	89	5,717	84	309	-55	-1,068	-47
64	6.3	—	160	1,733	93	—	-135	-386	-56
65	13.0	—	40	2,336,026	27	—	-37	*[5]	-19
66	10.1	-326	18	12,511	15	349	-15	-4,638	-11
67	19.2	—	41	*[5]	36	—	-44	*[5]	-43
68	17.0	—	18	1,449	19	—	-18	-915	-18
69	22.9	-764	15	30,292	11	632	-23	-27,743	-16
70	15.7	-348	24	225	15	261	-20	-99	-12
71	11.6	-210	102	1,988	57	344	-87	-407	-41
72	32.7	-181	2	*[5]	12	238	-45	*[5]	-41
73	12.2	-163	79	110	41	213	-67	-66	-30
74	21.5	—	17	71	11	—	-14	-46	-9
75	[6]4.4	—	—	—	—	—	—	—	—
76	5.3	—	61	79	63	—	-340	-84	-64
77	4.6	—	763	407	218	—	-336	-201	-83

Note: The sensitivity of the data changes were calculated independently for each data group. No joint data group changes were tested.

[1]*See table 2 for description of sample cell number.*

[2]*This is the simple average IROR of all non-zero cases in the cell.*

[3]*The upper IROR threshold is the average percentage data change required to increase the IROR level by one percentage point of interest above the original estimate.*

[4]*The lower IROR threshold is the average percentage data change required to lower the IROR level one percentage point of interest below the original estimate.*

[5]*The percent exceeds 9,999,999.99.*

[6]*Only one case had a non-zero IROR, therefore no sensitivity calculated for the cell.*

Appendix Table A11. Weighted average IROR under the direct cost option of the FIP treatment, by sampling cell

Species group and practice	State														
	Missouri	Alabama	Arkansas	Florida	Georgia	Louisiana	Mississippi	North Carolina	Oklahoma	South Carolina	Texas	Virginia	Other South	Eastern residual	Total
Southern pine, plant bare land	—	14.1	13.7	13.2	15.5	14.6	14.9	11.8	—	14.3	12.7	13.7	9.1	—	13.9
Southern pine, site preparation and planting	—	9.5	10.5	11.8	12.3	12.1	13.3	9.1	9.9	10.5	9.7	11.3	7.8	—	10.7
Southern pine and oak-pine, precommercial thin, and release	10.4	—	9.6	—	12.8	13.5	12.3	—	6.9	—	12.1	13.3	5.8	—	9.2
Southern pine, and oak-pine, cull tree removal	1.0	—	10.0	—	7.9	22.6	—	—	—	—	—	—	8.7	—	
Northern pine, site preparation and planting	—	—	—	—	—	—	—	6.4	—	—	—	—	—	—	—
Eastern residual	—	—	—	—	—	—	—	—	—	—	—	—	—	5.8/40.9	—
Total	5.6	10.4	10.7	12.6	12.3	14.1	10.4	9.1	8.3	7.5	11.5	11.8	—	—	—

Species group and practice	State										Total
	Michigan	Minnesota and Wisconsin	Vermont	Maine	New Hampshire	New York	Pennsylvania	Indiana	Missouri	Other North	
Northern pine, and spruce-fir, plant bare land	8.5	6.1	—	7.3	—	—	8.0	—	—	7.3	7.4
Northern pine, and spruce-fir, site preparation and planting	8.1	5.8	—	—	—	—	5.5	—	—	5.4	6.0
Northern pine, and spruce-fir, precommercial thin, and release	—	—	—	8.5	10.2	—	—	—	—	10.0	9.7
Northern pine, and spruce-fir, prune	14.8	11.7	—	—	—	—	—	—	—	7.4	10.3
Oak-hickory, precommercial thin, and release	—	—	—	—	—	—	8.4	10.3	4.5	12.1	8.0
Oak-hickory, cull tree removal	—	—	—	—	—	—	—	5.1	4.9	5.0	
Maple-beech-birch, precommercial thin, and release	12.4	—	9.5	18.9	8.6	22.5	17.1	—	—	17.5	15.3
Maple-beech-birch, cull tree removal	13.6	—	—	—	—	11.9	—	—	—	13.5	
Total	10.1	5.2/8.9	8.3	9.4	9.5	20.0	9.6	14.6	5.6	—	—

Species group and practice	Region		
	Pacific coast	Rocky mountains	Total
Douglas-fir and ponderosa pine, plant	5.7	—	5.7
Douglas-fir and ponderosa pine, precommercial thin and release	16.7	—	16.7
All types, plant	—	1.0	1.0
Douglas-fir and ponderosa pine, precommercial thin and release	—	3.3	3.3
Rocky mountains residual	—	3.0	3.0
Total	9.4	2.9	—

Appendix Table A12. Financial return and yield results by broad practice groups under the total cost option

Species group and practice	Average IROR	Total B/C ratio @6-3/8%	Total PNW @6-3/8%	Cases earning 6-3/8%	Average MAI increase	Total yield increase	
						Sawtimber	Pulpwood
	(percent)		*(mil. dollars)*	*(percent)*	*(cu ft/ ac/yr)*		*(mil. cu ft)*
Southern pine, plantings	10.7	3.2	28.04	89	108.1	320.1	229.8
Southern pine and oak-pine, timber stand improvement	8.5	2.8	4.02	72	45.4	45.2	33.4
Northern conifer, plantings	6.1	0.5	-0.18	29	122.5	298.1	27.9
Northern conifer, timber stand improvement	7.6	0.8	0.30	50	24.6	13.5	3.7
Hardwood, planting	9.4	15.3	6.02	57	44.0	6.1	2.0
Oak-hickory, timber stand improvement	4.3	0.8	0.45	37	9.5	25.6	2.4
Black walnut & cove hardwood, timber stand improvement	19.5	12.0	7.81	77	16.3	10.9	0.2
Northern hardwood, timber stand improvement	12.6	3.2	2.48	76	10.4	13.5	4.6
Western conifers, planting	4.8	3.2	0.95	47	67.1	2.3	2.4
Western conifers, timber stand improvement	6.7	1.6	0.53	30	15.6	2.6	0.5
Total, all species and practices	9.4	3.0	50.44	63	74.8	737.8	306.8

Appendix Table A13. Weighted average IROR under the direct cost option of the FIP treatment, by detailed species and practice groups

Species	Practice							
	Plant bare land	Site preparation and planting	Understory release	Precom-mercial thin	Intermediate	Prune and intermediate	Prune	Total
Slash pine	13.8	12.2	17.0	27.2	3.2	—	—	12.2
Longleaf pine	11.3	13.9	—	—	8.8	—	—	13.2
Loblolly pine	14.0	10.1	12.6	13.8	7.7	—	—	11.0
Shortleaf pine	3.9	5.9	6.8	—	8.6	—	—	7.5
Virginia pine	4.6	4.8	—	—	4.2	—	—	4.2
Oak-pine	—	—	—	—	4.8	—	—	4.8
Red pine	8.2	6.9	—	—	6.4	3.8	13.3	8.2
White pine	6.7	5.7	7.4	—	9.8	12.6	8.4	7.7
Jack pine	—	5.1	—	—	7.0	—	—	5.2
Spruce-fir	6.8	6.7	—	—	3.6	—	—	6.1
Hemlock	—	—	—	—	1.9	—	—	1.9
Larch	7.5	0.0	—	—	—	—	—	0.7
Oak-hickory	2.3	7.1	—	—	4.7	—	—	4.7
Cove hardwood	—	4.4	—	—	16.0	—	—	14.5
Black walnut	14.0	14.0	—	—	16.9	—	14.6	24.0
Northern hardwood	—	—	—	—	15.0	—	—	15.0
White birch	—	—	—	—	14.3	—	—	14.3
Douglas-fir	12.4	7.2	—	—	14.8	—	—	10.8
Ponderosa pine	—	2.0	—	—	3.7	—	—	3.2
Lodgepole pine	—	—	—	—	1.1	—	—	1.1
Total	11.6	10.1	11.4	20.9	8.6	24.0	11.9	10.2

Appendix Table A14. Percentage of cases that exceeded the silvicultural thresholds and the additional percentage that could not earn 6 3/8% by detailed species and practice groups

Species	Practice							
	Plant bare land	Site preparation and planting	Understory release	Precommercial thin	Intermediate	Prune and intermediate	Prune	Total
Slash pine	[1]*24* [2]0	*6* 1	*0* 0	*0* 0	*82* *0*	—	—	*11* 1
Longleaf pine	*29* 0	*0* 0	—	—	*44* 0	—	—	*11* 0
Loblolly pine	*9* 0	*7* 0	*3* 0	*0* 0	*20* 10	—	—	*7* 0
Shortleaf pine	*17* 50	*0* 78	*11* 6	—	*33* 0	—	—	*20* 19
Virginia pine	*0* 100	*0* 100	—	—	*78* 0	—	—	*41* 47
Oak-pine	—	—	—	—	*70* 11	—	—	*70* 11
Red pine	*11* 11	*3* 16	—	—	*0* 33	*64* 0	*3* 3	*10* 11
White pine	*23* 18	*19* 45	*0* 0	—	*9* 7	*16* 0	*0* 22	*17* 22
Jack pine	—	*0* 100	—	—	*0* 0	—	—	*0* 87
Spruce-fir	*24* 17	*8* 11	—	—	*35* 30	—	—	*23* 18
Hemlock	—	—	—	—	*18* 82	—	—	*18* 82
Larch	*0* 0	*100* 0	—	—	—	—	—	*58* 0
Oak-hickory	*50* 0	*0* 33	—	—	*56* 1	*100* 0	—	*54* 2
Cove hardwood	—	*33* 0	—	—	*28* 0	*0* 0	—	*29* 0
Black walnut	*40* 0	*10* 0	—	—	*9* 20	*0* 0	*5* 0	*11* 5
Northern hardwood	—	—	—	—	*19* 1	—	—	*19* 1
White birch	—	—	—	—	*28* 0	—	—	*28* 0
Douglas-fir	0 0	*27* 0	—	—	*26* 26	—	—	*23* 11
Ponderosa pine	—	*80* 9	—	—	*45* 29	—	—	*61* 19
Lodgepole pine	—	—	—	—	*33* 67	—	—	*33* 67
Total	*15* 10	*10* 10	*4* 1	*0* 0	*33* 6	*19* 1	*3* 7	*17* 8

[1]*Percentage of cases that exceeded silvicultural thresholds.*
[2]*Additional percentage of cases that failed to earn 6-3/8%*

Appendix Table A15. Weighted average increase in MAI per acre by detailed species and practice groups

Species	Practice							
	Plant bare land	Site preparation and planting	Understory release	Precom-mercial thin	Intermediate	Prune and intermediate	Prune	Total
Slash pine	103.8	105.0	87.9	52.5	4.5	—	—	99.9
Longleaf pine	57.3	100.4	—	—	5.1	—	—	86.6
Loblolly pine	126.0	105.7	91.2	43.1	12.9	—	—	102.7
Shortleaf pine	49.1	64.1	38.4	—	5.6	—	—	25.4
Virginia pine	50.2	46.7	—	—	9.9	—	—	13.8
Oak-pine	—	—	—	—	3.2	—	—	3.2
Red pine	131.6	107.6	—	—	34.9	16.0	0.0	104.4
White pine	122.5	129.5	108.5	—	40.0	34.6	0.0	92.3
Jack pine	—	59.2	—	—	35.0	—	—	57.7
Spruce-fir	105.9	107.8	—	—	3.6	—	—	83.9
Hemlock	—	—	—	—	-3.0	—	—	-3.0
Larch	116.0	0.0	—	—	—	—	—	10.8
Oak-hickory	39.1	100.8	—	—	9.5	0.0	—	10.3
Cove hardwood	—	43.6	—	—	26.9	10.0	—	29.1
Black walnut	33.1	34.6	—	—	4.1	5.3	0.0	12.1
Northern hardwood	—	—	—	—	9.8	—	—	9.8
White birch	—	—	—	—	32.7	—	—	32.7
Douglas-fir	177.8	105.0	—	—	39.9	—	—	77.0
Ponderosa pine	—	12.4	—	—	1.6	—	—	5.0
Lodgepole pine	—	—	—	—	0.7	—	—	0.7
Total	121.5	104.1	78.6	48.1	11.8	18.1	0.0	73.8

Mills, Thomas J., and Daria Cain. 1978. Timber yield and financial return performance of the 1974 Forestry Incentives Program. USDA For. Serv. Res. Pap. RM-204, 56 p. Rocky Mt. For. and Range Exp. Stn., For. Serv., U.S. Dep. Agric., Fort Collins, Colo. 80526.

Analysis of the timber production performance of the 1974 Forestry Incentives Program (FIP) showed that the average "real" rate of return on timber-associated inputs and outputs of the 1974 investments was 10-1/4% on the direct treatment costs. Seventy-five percent of the cases earn a 6-3/8% return. The first rotation yield increase is estimated at 1.04 billion cubic feet, mostly softwoods, occurring within 50 years of the initial treatment. The program overall had high average returns, but some major segments had low returns. Five recommendations, aimed at eliminating low return segments by developing silvicultural guidelines for the screening of cases, development of maximum cost standards, and insuring the follow-up treatments are taken, are proposed.

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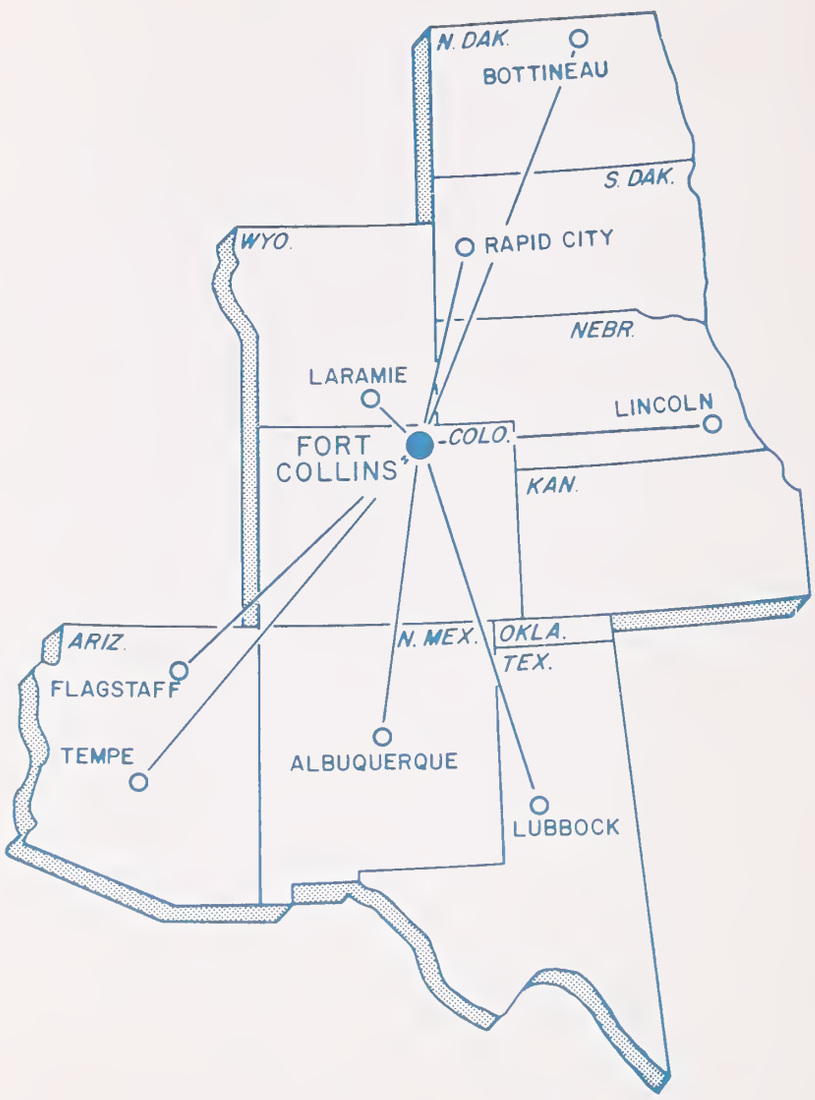
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LARAMIE
LINCOLN
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OKLA.
TEX.
FLAGSTAFF
TEMPE
ALBUQUERQUE
LUBBOCK